SCIENTIFIC AMERICAN
No. SUPPLEMENT 211

Scientific American Supplement, Vol. IX., No. 211. Scientific American, established 1845. NEW YORK, JANUARY 17, 1880. Scientific American Supplement, $5 a year. Scientific American and Supplement, $7 a year.

MACHINES FOR THE PRODUCTION OF ORNAMENTAL PAPERS.

At the last Paris Exhibition there were shown several new machines for use in the various operations concerned in the production of figured papers of the more elegant, tasty, and expensive kinds. These apparatus, invented by M. E. Gontard, are constructed by Messrs. Tulpin Frères, at Rouen, who are well known through their tissue-printing machines, which are somewhat similar to those used in printing paper hangings.

M. Gontard's series of apparatus comprises everything necessary for the preparation and printing of papers, such as: Machines for printing 2, 4, 8, 12, 18, and even 24 colors; machines for varnishing and deepening the tint of fancy papers, provided with four or eight revolving brushes; drying apparatus to be placed at the ends of the shading and printing presses; satining machines; apparatus for washing the endless cloths that are used for distributing the colors; dampening machines; machines for rolling, cutting, figuring, etc.; different apparatus for grinding and preparing colors; and, finally, a special press for numbering the rollers.

We reproduce herewith, from *La Revue Industrielle*, figures of some of these machines. We will not enter into a description of their mode of operation, which is similar to that of other like machines in use; we will simply point out the special features that characterize them.

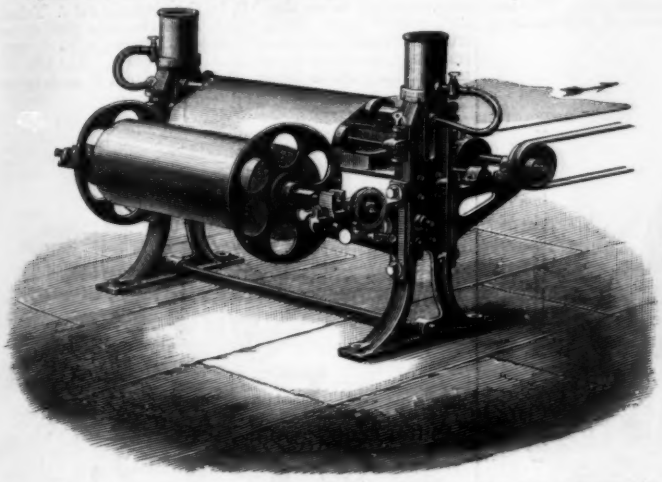


FIG. 1.—MACHINE FOR DAMPENING FIGURED PAPERS PREVIOUS TO SATINING.

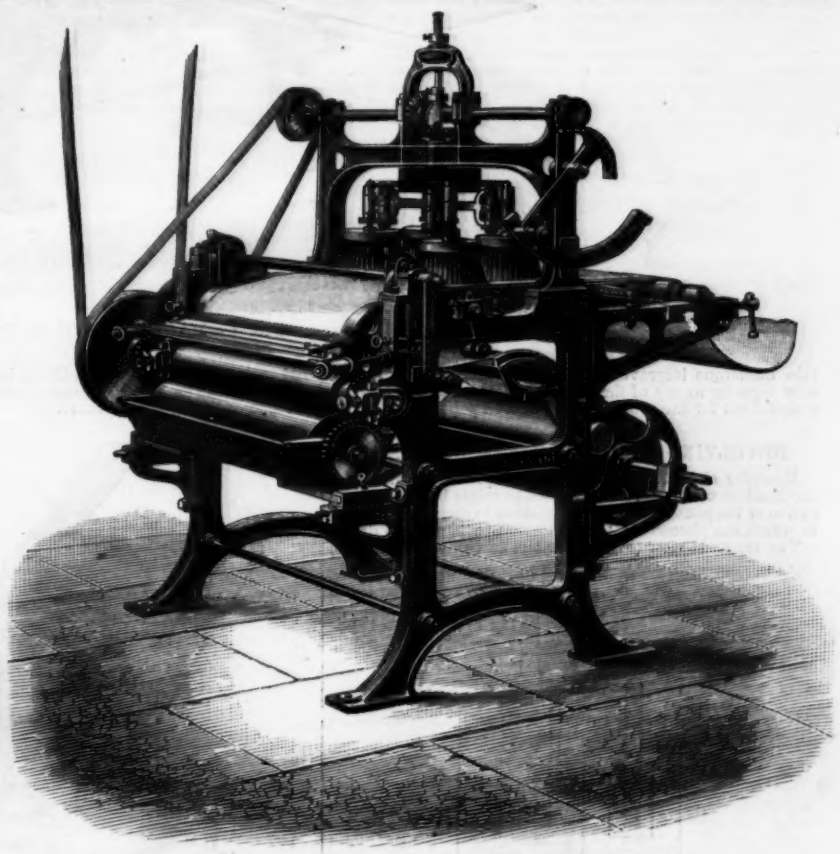


FIG. 2.—MACHINE FOR SHADING AND SIZING PAPERS.

The machine for printing papers in eight colors is noteworthy by reason of the general arrangement adopted to allow of easy access to and control of its working parts. The mode of regulating the graved cylinders, the endless cloths, the color pans, and the paper bobbin, are very complete and extremely accurate. The machine possesses great solidity, and is capable of printing 3,000 rolls a day, without vibration or shock. The satining machine is provided with an entirely new arrangement, by means of which alternate backward and forward movements are communicated to the cylindrical brushes. The crossed-tooth gearing allows the machine to work with great rapidity and with but little noise; and the distribution of the talc is effected automatically by the aid of sheepskin rubbers, which act in the same way as the hand tampon.

The paper guides are of turned cast iron. Small winding rollers cause the brushes to bear upon a certain length of paper instead of having but a single point of contact; and there are special arrangements for the regulation of the brushes and paper. In the apparatus for dampening the papers to be satined we will cite as distinctive characteristics: The method of regulating the dampener, which can, if necessary, perform its movements without any contact with the paper; the possibility of dampening one of the edges of the paper more than the other; and, finally, the use of a new double-spring brake.

In the machine for shading the papers, and which is likewise employed for sizing and varnishing them, the round brushes have an epicycloidal movement, and each one can be regulated separately. The presser has a covering of India rubber, as in the machine for printing; the parts of the mechanism for paying out the rolls are of bronze; and the color pans are of copper. We may also state that the machine has a paper-guide of cast iron, turned, and a double spring brake.

From the brief notes here given it will be seen that the new machines constructed by the Messrs. Tulpin con-

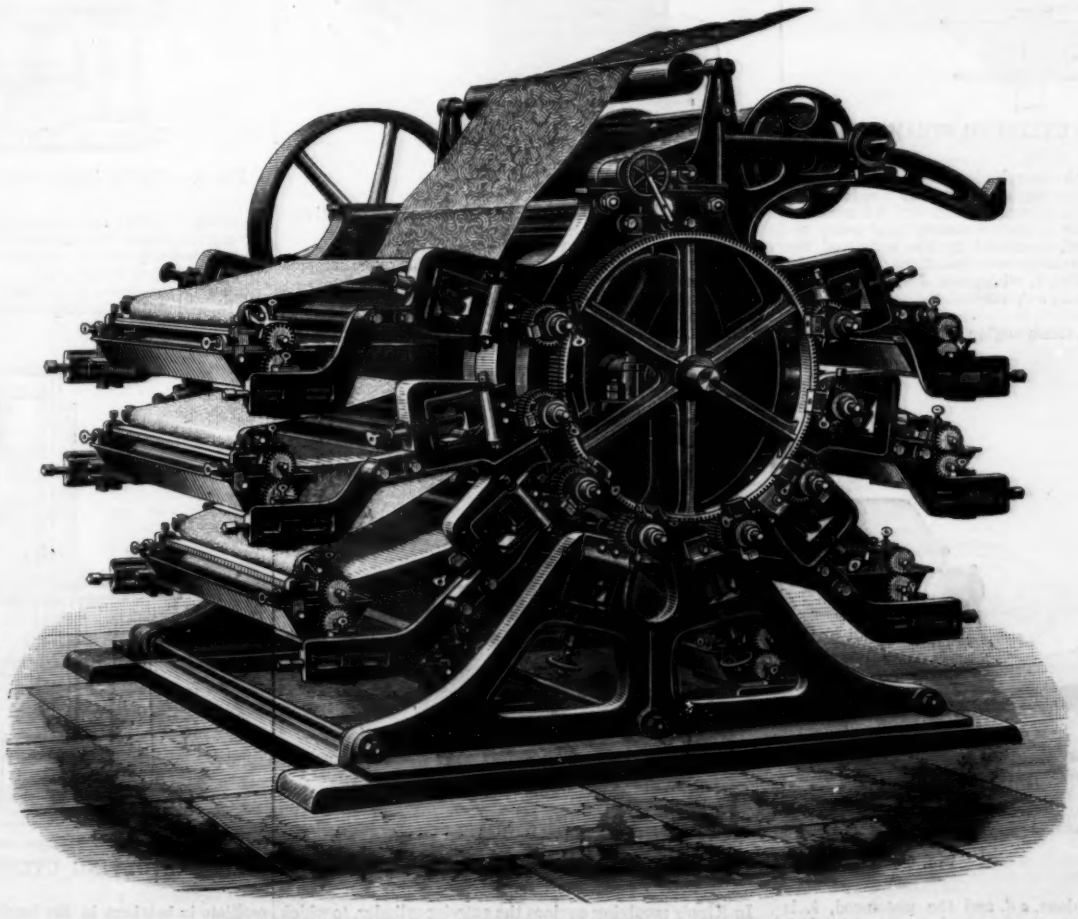


FIG. 3.—MACHINE FOR PRINTING PAPERS IN EIGHT COLORS.

MACHINES FOR THE PRODUCTION OF ORNAMENTAL PAPERS.

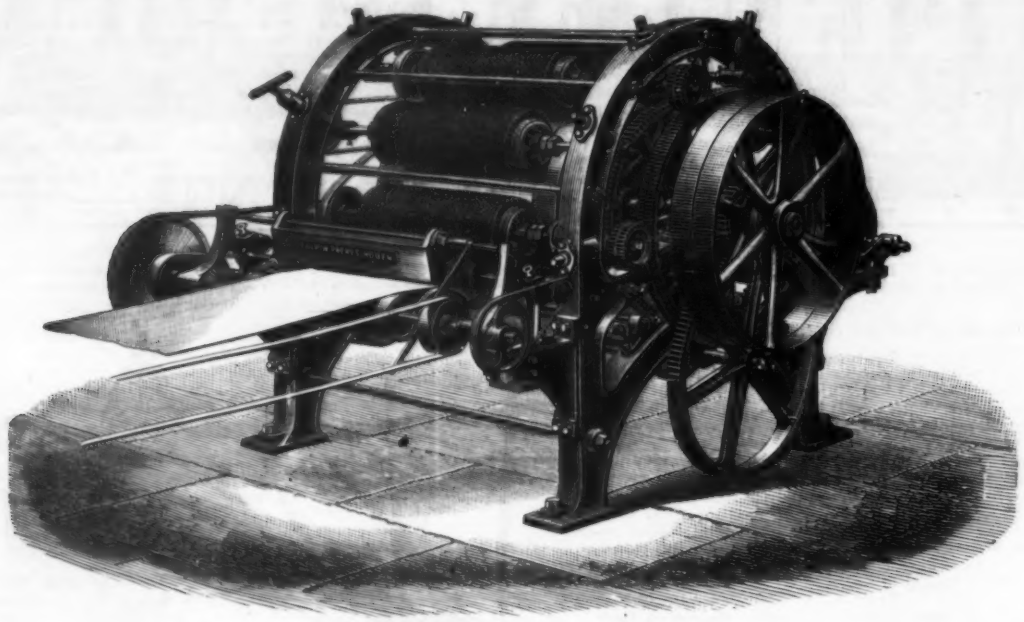


FIG. 4.—MACHINE FOR SATINING PAPERS.

tain numerous improvements, which make them undoubtedly superior to any of the machines that have been hitherto constructed for the production of figured papers.

REVOLVING CYLINDER STEAM ENGINES. *

Revolving Cylinder Steam Engine.—One whose cylinder is mounted on trunnions, and is caused to rotate by the reciprocation of the piston, in contradistinction to the rotary engine, in which the pistons rotate on an axis within a steam drum.

The sectional view (Fig. 1) exhibits an engine of this class,

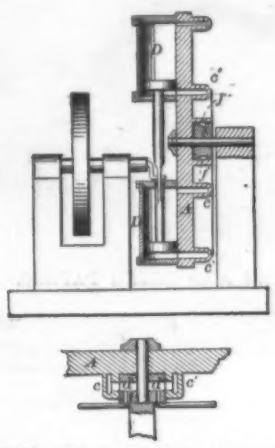


FIG. 1.—REVOLVING CYLINDER STEAM ENGINE.

having a fly-wheel, A, with two cylinders, D D, rigidly attached to it and placed opposite each other in a radial line. These cylinders have a common piston-rod, which is attached at its center to a crank-pin in such a manner that every revolution of the fly-wheel, A, caused by the action of the steam in the cylinders produces two revolutions of the crank.

The stationary disk-valve, I, with ports, *d d'*, and grooves, *f f'*, and pipes or channels, *c c'*, control the admission and exhaust of steam.

In Scott and Morton's steam-engine (Fig. 2), the cylinder, *a*, is mounted on trunnions, *c d*, and the piston-rod, *b*, is connected to a wrist-pin on the fly-wheel, *f*. The trunnion, *c*, is journaled eccentrically in the hub of the fly-wheel, so that each revolves independently on its own axis. Previous to starting the engine, the piston is placed at half-stroke on one side of the fly-wheel center.

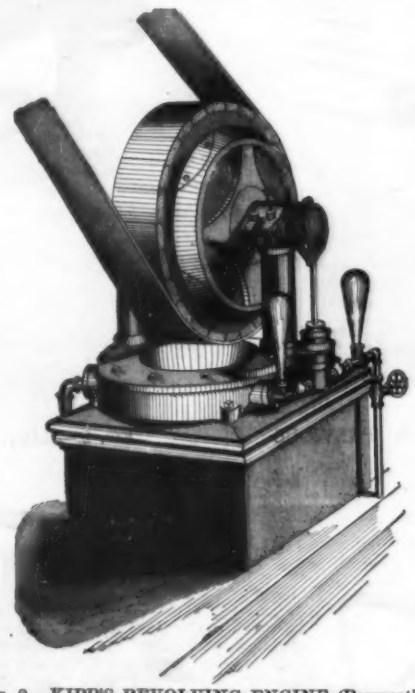


FIG. 3.—KIPP'S REVOLVING ENGINE (Perspective View).

Steam is admitted to and exhausted from the cylinder through ports in the trunnion, *d*. *e* is the steam-chest.

The valve motion is controlled by the lever, *g*, by which the engine is started or reversed, and by moving it back or forth on the arc, *h*, the lap of the valve is changed.

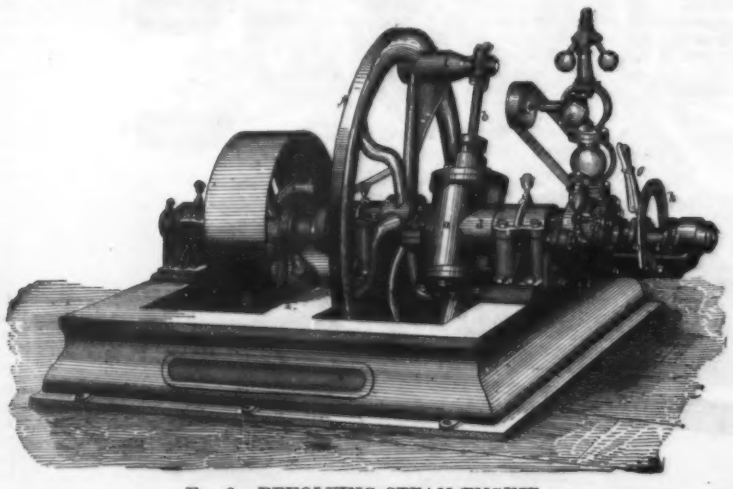


FIG. 2.—REVOLVING STEAM ENGINE.

In Kipp's revolving engines the exterior cylinder, to which a belt may be directly applied, it being surrounded by a lagging for that purpose, is caused to rotate by the reciprocation of two pistons with duplicate heads in cylinders whose axes are at right angles to each other. The piston-heads, *a a'*, are connected, as are also *b b'*, by the pieces, *c c' c' c'*. Yokes, *d d'*, connect these with a crank, *e*, on the main shaft of the trunk. Steam is admitted through the valve, *f*, to the central space, *g*, which serves as a steam-chest. The arrangement of the ports is shown at *i*. The drum is mounted on trunnions, through one of which the steam enters, the other serving to exhaust through one of the hollow pillars, *k*, into the feed-water heater, *l*; an eccentric on the main shaft also operates the feed-water pump.

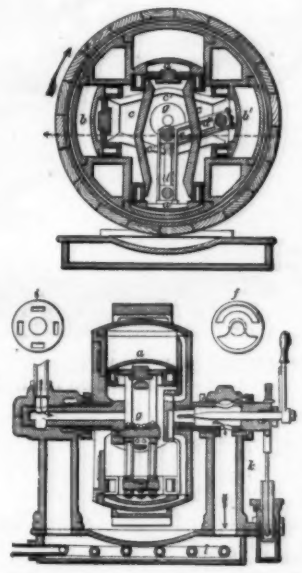


FIG. 4.—KIPP'S REVOLVING ENGINE (Sections).

In Fig. 5, the drum, C, rotates in bearings, the steam passing in and out at the respective trunnions. The cylinders oscillate in bearings in the heads of the drum, and revolve with it. The reciprocating pistons are connected by cranks to planetary gears, H H, which mutually and severally engage a fixed sun-wheel, I, on the central axis. Power is transmitted by a belt on the drum.

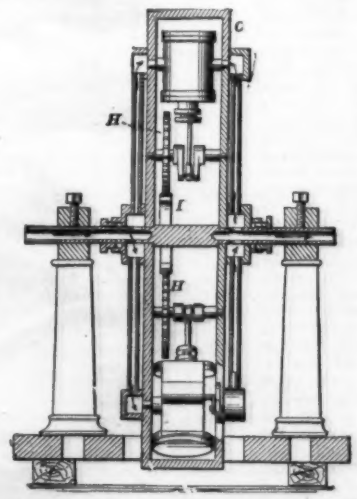


FIG. 5.—REVOLVING CYLINDER STEAM ENGINE.

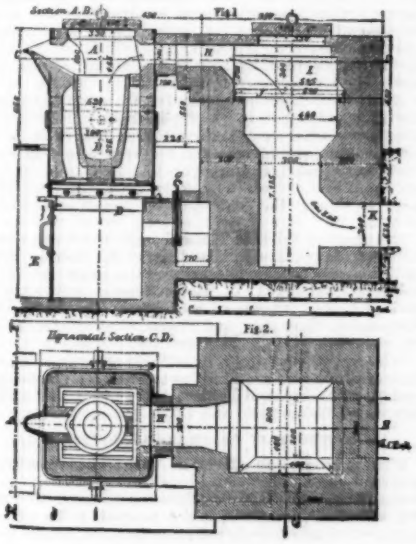
* From "Knight's Mechanical Dictionary," H. O. Houghton & Co., publishers, New York and Boston.

NEW APPLICATIONS OF CENTRIFUGAL PUMPS.

THE current number of the *Revue Industrielle* contains figures and descriptions of some of the more interesting uses to which Messrs. Dumont & Co., of Paris, manufacturers of centrifugal pumps, have recently applied this form of hydraulic apparatus. These are as follows: *Submersion pump.*—A form of the centrifugal designed for submerging vineyards in order to effect the destruction of the phylloxera. The application has been made at several points along the Herault, the Dordogne, and the Gironde with the happiest results. The soil, far from being impoverished by the inundation, has profited by the deposition of slime, and the working of the pumps was in nowise hindered by the earthy matters in suspension in the water. *Exhaust pump for graving docks.*—To ground a ship in graving docks requires the rapid removal of a great body of water, 18,000 cubic meters in ordinary docks, 25,000 to 30,000 in large ones, and 40,000 in those designed for the larger transatlantic vessels. In the commonest arrangement adopted by Messrs. Dumont & Co., the pumps are placed in a draining well communicating with the dock. The mechanism, lodged thus in the upper part, is in plain view, and the distance between the motor and the pump is such that the latter may be driven by belts, at a normal speed. To give some idea of the power of centrifugal pumps for such purposes it may be stated that at the sluice of the Penhouet basin, at Saint-Nazaire, they are made to raise 6,000 cubic meters per hour. *Pump for dredging soft mud.*—This application is based on the same principle as that of the Bazin extractor. The pump sucks up at the same time both the liquid and the disintegrated mud held in suspension, and empties the whole over the side of the boat. The raising of sewer waters filled with all kinds of detritus can only be effected in a continuous manner by centrifugal pumps. *Pumps mounted on turbines.*—Some years ago M. Belgrand made a very ingenious application of the centrifugal pump at the time of constructing an aqueduct to receive the waters of the river Vanne. There were a number of sources of water below the level of the general aqueduct, and in order to raise them he had recourse to centrifugal pumps, mounted directly on the vertical axle of turbines, which were put in motion by water stored up at a level above that of the aqueduct. This arrangement was applied to four Dumont pumps, which are still working continuously at the sources of the Vanne. The same arrangement has been proposed, and partially put in practice in Paris, for removing infiltrated waters from the districts lying along the borders of the Seine in that city. But it will probably have to be abandoned owing to the expense of running the turbines, it being necessary to obtain the water supply from the city mains for that purpose.

NEW OSCILLATING CRUCIBLE FURNACE.

A NEW form of portable crucible furnace has lately been introduced with great success in France by M. M. A. Piat, of Paris, and the construction of which will be understood from the engravings below. Of these, Fig. 1 is a longitudinal section through the center of the furnace; Fig. 2 is a sectional plan on the line C D; Fig. 3 is a front elevation; and Fig. 4 is a section on the line G H, of the heating chamber to the rear of the furnace. The apparatus consists of a rectangular sheet iron chamber lined with firebrick, A. The bottom of this chamber is formed with grate bars, and near the top is a projecting spout, also protected with firebrick. The top of the chamber is covered in with a firebrick slab. On the grate bars, and in the center of the chamber, is a cylindrical mass of firebrick, on which the crucible, B, rests; this crucible is held in place by a projecting lip. The chamber is encircled by an iron strap, carrying on opposite sides two trunnions, by means of which it can be lifted and manipulated. It rests upon circular bars placed on an iron frame built into the brickwork of the furnace. Below may be placed, if desired, an open iron vessel to receive the contents of the crucible should the latter break. This vessel is not shown in the drawing. The space around the crucible is filled in with fuel, and air is supplied by a fan through an opening in the furnace, which can be closed by the damper, G. The products of combustion pass through a passage, H, in the top of the furnace, a projection in the movable chamber making a close joint with the fixed portion, as shown. They then pass downward through the chamber, I, which is fitted with a grate (see Fig. 4) and on to the uptake, R. This chamber, I, is employed for the preliminary heating of ingots, old brass, etc., which are afterward to go into the crucible. In another arrangement, the space below the grate of I is filled with vertical iron tubes through which the gases of combustion pass, heating the air which is afterward to supply the furnace, and which is introduced through an opening in the brickwork. When it is desired to pour the contents of the crucible the chamber is raised by the trunnions either with a crane for the larger sizes, or by suitable handles for the smaller ones. In another arrangement, the whole of the furnace is mounted on wheels, a small crane being attached to the frame. The advantages claimed for this arrangement are a marked economy of fuel and labor, a greater durability of the crucibles, and increased rapidity of melting. As we have already said, this form of furnace is being largely introduced in France, and the experience obtained with it appears to bear out the various claims made for it.—*Engineering.*



NEW OSCILLATING FURNACE.

ENDLESS RAIL RAILWAY.

CLEMENT ADER'S SYSTEM.

ADER'S endless rails, which are adapted for use on any kind of a vehicle, are composed of pieces 12 or 15 inches long, jointed together, and their ends resting in a common shoe so as to give the track the necessary firmness. The rail

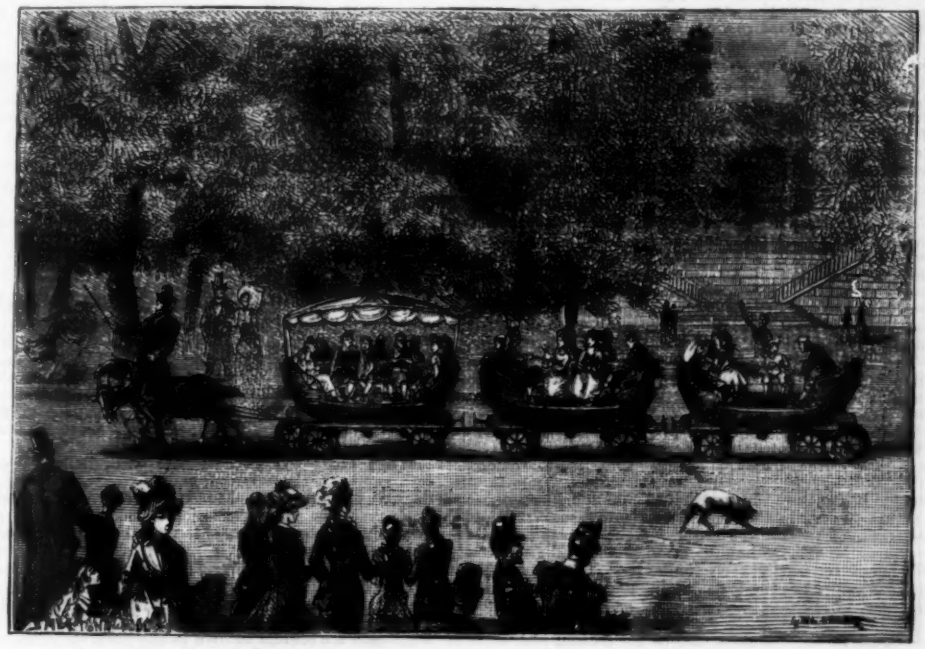


FIG. 1.—ENDLESS RAILS ADAPTED TO A TRAIN OF GOAT CARRIAGES IN THE GARDEN OF THE TUILERIES.

passes over and under every wheel in the train, and the one on the left side and that on the right are independent of each other. In measure as the train moves forward, the parts of the track lay themselves down in front and are lifted up in the rear. In front they are guided by two distributing wheels (Fig. 2), controlled by the traction itself, so that if the effort of the latter is directed either toward the right or left, the endless track automatically follows the same direction. In the rear of the train the rail passes around two other wheels, but, as in curves, the spaces passed over by the two rows of carriage wheels are not equal, while the length of the endless track remains invariable, it follows that one side of the track elongates and the other shortens with respect to the last carriage. For this reason the lifting wheels are provided with a differential movement, when one draws back the other advances just so much, and in this way the track is constantly laid down and raised up regularly, whatever be the curve passed over. The wheels of the vehicles are provided with a double flange to prevent them from jumping the rail, and are mounted on any sort of axle that may be devised, but the kind used on railway carriages is preferable.

The system, viewed from a mechanical standpoint, exhibits one striking feature, and that is the small amount of effort required to put the train in motion. The rolling resistance measured by the dynamometer is found to be only 12 kilogrammes (26 pounds) to the ton; and it may be boldly asserted that on the same road, and with an equal amount of traction, a weight can be transported by the endless rails double and even triple that by ordinary means. The thing can be verified every day in the garden of the Tuileries, in a small way, it is true, but still large enough to be satisfactory. The three carriages, drawn by goats, contain thirty children (Fig. 1). They are often completely filled, especially on Sundays, and there are only two goats to draw them—always the same ones—from 2 o clock till 9 in the evening. Every one knows the very limited strength of these animals, yet without tiring they perform their service regularly, often drawing loads of 2,200 pounds (children and train). To draw a similar load in three other carriages with ordinary wheels, it would take a dozen goats, or four to each carriage; and the latter, moreover, is the number harnessed to the little carriages in which children ride in the Champs-Elysées. The economy of the system, then, cannot be denied. The normal speed is from 2½ to 4 miles per hour; in other words, the system is not adapted for traveling purposes, but only for the transportation of merchandise. The method might be applied quite extensively on all routes and for all sorts of vehicles, horses, oxen, and road machines being used for traction. M. Ader, the inventor, designed the system particularly for use in the Landes. By the aid of their shoes, the rails laid very well on the quicksands, and on such grounds as these the track is laid and works as well as on an ordinary road. So that in the Landes, instead of ballasting roads with stone at great expense, it will only be necessary to mark them out and cut down the highest ferns. It would prove a genuine fortune for that country, for there are enormous extents of lands and pine forests there, where the wood and resin are lost for want of proper roads to get at them.

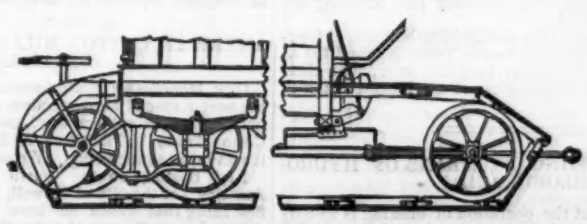


FIG. 2.—FRONT AND REAR OF A TRAIN PROVIDED WITH A SYSTEM OF ENDLESS RAILS.

[WRITTEN FOR THE SCIENTIFIC AMERICAN.]

IMPROVEMENTS IN BRIDGES.

By RICHARD B. OSBORNE, C.E., Wilmington, Del.

THERE is no more difficult problem presented to the engineer than the providing a way for the quick transit of railway trains over wide waterways where deep and rapid currents exist, and the grade level is often high above the stream.

The long spans attained by our American builders have reached about their limit. To construct spans of much greater length, and avoid the delays consequent on deep water foundations and expensive piers, liable to injury from ice and flood, and gain elevated and protected sites for the erection of masonry, are features that often might be provided for if our experience justified us in so doing.

If sound principles in practical mechanics be united and brought together into mutual relations, they will form a system, the full efficiency of which will be measured by more than the separate values of the component parts.

Applying this axiom to the systems of bridge construction which have produced our successful structures in the United States, and to the suspension principle, well known, but avoided for railway use because of its inability to resist undulatory movements, we obtain a union of tried principles brought into such mutual relations, that where any deficiency exists in one system it is counteracted by the opposing efficiency of another.

Such a combination will bring into positive action the law of resultant opposite forces, creating a neutralization of much of the great strains which prevent the use of our systems of construction beyond certain limits of span.

To elucidate the foregoing, we have assumed a clear span of nine hundred feet, carrying a live load of 4,480 lb. per foot over the entire span, which is sufficient for a double track bridge of this length.

In this combined structure the main suspension chains,

which are composed of plates of iron 1⅛ by 14 inches, have a deflection of $\frac{1}{12}\frac{1}{12}$.

The secondary suspension chains, which form the top cords of the bridge truss, are of plates of like dimensions, and have a deflection of about $\frac{1}{9}$.

The bottom chords are made of similar plates, and rise as a flat arch to a central camber of three feet. This arch, experiments have shown, will be kept to its uniform shape by the power of the truss.

All of these chains are supplied with expansion rollers—the main chains on the tops of the towers—the secondary chains on rollers set on the vertical posts in the pier panels, and the bottom chords on those set on the pier seats. Contraction and expansion are thus fully provided for.

The main suspension chains are formed with spaces between their plates, to receive the plates composing the secondary suspension chains, and these two chains are thus easily incorporated for a distance of about one-fifth of the span at the center, and united, form a top chord of the required sectional area to resist the compressive forces of the trusses at that point, the catenary curves being flattened to coincide with the line of the truss for this distance.

The span assumed is made up of three sections. The central section, of about one-fifth of the span, being of the Pratt truss; and the two other sections, each about two-fifths of the span, are of the Howe truss. These last sections spring as cantilevers from the piers, and unite with the central section, the three sections having continuous top and bottom chords throughout.

The deflection of the secondary chains is arranged to give a height of cantilever truss on each pier of about one-eighth of the length of same, and at its junction with the Pratt truss of the central section, a height of truss of one-tenth of the length of that section.

The cantilever Howe truss thus becomes a tapering lever, the average height of which is about one-tenth of its length. Its weight is thus gradually decreased toward the center of the span, to meet the lighter Pratt truss of the central section. The practical working of this combined structure will be as follows:

The main and secondary chains will sustain with their own weight the entire weight of the *central section* of the span, including its own maximum live load; for here both chains are united for a distance equal to one-fifth of the span, to form *its top chords*. The trusses are thus relieved of nearly one-half of the whole weight and live load of the structure; the injurious effect of leverage of a long span is avoided, and the strength of the structure is consequently increased.

As chains in suspension, the strains on them will be *tensile;* but as the main chains for one-fifth of the span, and all of the secondary chains, form the top chords of a powerful truss, there will be also a strong *compressive* force exerted on them, which brings into action the law of "*resultant opposite forces,*" when the lesser will neutralize so much of the greater as is equal to its own quantity, and an effective force will result in the direction of the greater equal to their difference; which is self evident.

This difference; or effective force, in the assumed span is computed to be about 4,000 lb. per square inch of compressive force left to be exerted on the chains as top chords of the truss.

There can be no undulations in these suspension chains. They are incorporated together as shown to be the chief member of a rigid truss that admits of no such movements.

The ordinary "suspenders" to sustain the floors of suspension bridges are unnecessary by reason of the numerous ties that do duty in the truss. The floor rests on the *cross beams of the truss*, and the stiffness of the truss, aided at the middle of the span by the suspension chains, will prohibit any movement but a slight elastic depression at the middle of the span under passing loads, as due to the statical action of the structure.

Again, as the *compressive* force on the top chords of a truss are equal to the tensile strains on the bottom chords, if in the assumed span the compression be reduced to 4,000 lb. per square inch, will not the *tensile* strain on the bottom chords be decreased similarly? This is again under the same law as the previous.

Where spans exceeding 1,000 feet are required, the spaces between the main and secondary chains are intended to be filled up with a Pratt truss, using the main chains as the top chords, and the secondary chains as the bottom chords. Increased height of truss, proportionate to the span, is thus obtained at the piers.

The neutralization of opposite forces is here also to be found. The main chains having, by the Pratt truss, a compressive force exerted on them to neutralize an equal amount of their tensile strain, and *vice versa* with the secondary chains.

It is claimed that the practical construction of this bridge will be simple, and that it will afford facilities for the erection of long and elevated spans; that the four well understood systems of bridge construction are so thoroughly incorporated in it that there must be a complete unity of action among them, producing a strength measured by more than the separate values of the component parts.

The combination is believed by competent judges to be correct in principle, and that efficiency and economy are features that recommend it.

To the profession, and to the enterprising builders of long-span bridges, the Statical Suspension Truss is submitted as affording the means of further progress to uphold their present position as the constructors of the longest spans in the world.

HOLES FOR BLASTING BY MEANS OF HYDROCHLORIC ACID.

IT is well known that the operation of blasting is usually performed by boring a hole in the rock, and introducing into this hole a charge of gunpowder, which is then fired by means of a fuse.

The method of preparing holes for blasting with the aid of hydrochloric acid depends upon the same principle, except that for the purpose of enabling the charge of powder—and consequently the useful effect—to be increased, the bottom of the hole is enlarged by means of the acid into a larger or smaller cavity, so that the blast hole when completed has the form of a bottle with a very long neck.

The first that should engage the attention of the miner is an examination of the rock which has to be worked. If it be of a calcareous nature, and compact, one may be certain that the acid will perform its work, and that the result will be successful. If, on the contrary, the rock is argillaceous, or contains fissures, it is to be feared either that the acid will run into the cracks, or that the gases developed by the combustion of the powder will be lost in the crevices, in which case it would be better to have recourse to the ordinary but slower means of making the hole for the blast.

The holes to be treated by means of acid usually vary in depth from 13 to 33 feet, and the borer must consequently have that length, and bits $2\frac{1}{16}$ inches wide, when the rock to be bored is not too hard.

If, in order to reach a limestone rock, a granitic or silicious stratum has to be traversed, the width of the boring bit should not be less than $2\frac{3}{4}$ or $3\frac{1}{4}$ inches, as in this case the edge wears away rapidly. In short, whatever be the depth to which the hole is to be bored, its diameter should not be less than $2\frac{1}{16}$ inches at the bottom.

When the hole has been bored to the required depth, the bottom cavity is to be made by means of hydrochloric acid. For this purpose two tubes of gutta-percha are employed, one of which is $1\frac{1}{4}$ inch outside and $1\frac{7}{16}$ inch inside diameter, while the other should only be $\frac{1}{4}$ of an inch outside and about $\frac{3}{16}$ of an inch inside diameter. The larger tube is now placed in the hole, to within about 12 inches from the bottom, and the mouth of the hole and the tube filled in tight at the top with a stopping or tamping of hemp mixed with clay, so as to exclude the external air from the hole; the smaller tube is then introduced into the larger one and filled with hydrochloric acid, its upper end being immediately plunged in a vessel filled with the same acid. A siphon is thus formed, which at once begins to act, and the hole, as well as the outer tube, gradually becomes filled with acid. The level of the liquid would naturally rise to that of the vessel; but, as soon as the acid comes in contact with the limestone, it begins gradually to attack it, developing heat and evolving carbonic acid gas, which has no means of escape but by the space which exists between the inside of the larger tube and the outside of the smaller one.

The gas, as it increases in volume, rises and carries with it a certain quantity of the acid which has already produced its effect, and which is thus forced back into the vessel. The siphon continuing to act, the acid flows backward and forward from the hole to the reservoir and *vice versa*. This state of things goes on until the hydrochloric acid has become saturated with lime, and consequently ceases to have any further action upon the rock.

Although the operation above described goes on automatically and without any attention, it should, nevertheless, be watched by an intelligent workman, as cracks might occur at the bottom of the hole, or the hempen stopping might be forced out by the pressure of the gas; and in either case a waste of the acid would take place.

Should it be desired to excavate the hole at the bottom more rapidly than can be effected by the process above described, the acid as it is expelled from the hole may be received in another vessel, and the hole constantly supplied with fresh acid; in this manner the acid which comes in contact with the limestone, not having done any work, acts far more energetically, but the result can only be obtained with a considerable expenditure of acid.

If the rock which has to be worked contains fissures, by reason of which the siphon will not act, the method we have described may still be rendered available, by dispensing with the outer tube, fitting the upper end of the small tube to a vessel containing acid, and allowing the liquid to descend gradually, its flow being regulated by means of a tap. It will be necessary to move the tube from time to time in order to prevent the acid from always acting on the same spot.

When the lower cavity is sufficiently hollowed out the entire apparatus is removed, and it is only necessary to dry the hole by means of a wooden or iron rod, furnished with a plug of tow at its lower end; the latter being pressed down into the hole, the acid is soaked up and the capacity of the hole ascertained. It is then ready for the introduction of the powder, which may be ignited in the usual manner.

The effect produced by the explosion will be much greater than in the case of blasting with a hole of the usual form; the detonation takes place with a dull hollow sound, and the fragments are seldom thrown to any great distance; the surrounding mass of rock is gently raised, and the material is completely broken up, so as to yield easily to the crow-bar and mallet.

We append some information respecting the cost of producing holes for blasting by means of hydrochloric acid. The boring of the holes with the jumper or borer requires several workmen, and costs approximately as follows:

	s.	d.
Holes up to 8 ft. 3 in. in depth, per meter.....	2	0
From 8 ft. 2 in. to 11 ft. 6 in., per meter...	2	5
" 11 " 6 " 14 " 9 " " ...	3	2
" 14 " 9 " 18 " 0 " " ...	4	0
" 18 " 0 " 21 " 4 " " ...	4	10
" 21 " 4 " 24 " 9 " " ...	5	7
" 24 " 9 " 28 " 0 " " ...	6	5
" 28 " 0 " 34 " 8 " " ...	8	0

The hydrochloric acid costs (in France) 2s. per cwt., about 10d. being charged for the use of each, and, under ordinary circumstances, the above quantity of acid will form a cavity for from 26 to 33 lb. of ordinary blasting powder.

With respect to the saving in cost effected by the method we have described, it may be estimated at about 20 per cent. as compared with the old method.—*Universal Engineer.*

AMERICAN COTTON MILLS AS VIEWED BY AN ENGLISHMAN.

OUR Manchester contemporary, the *Textile Manufacturer*, has sent a special correspondent over to this country to report upon the subject of "American Competition in the Cotton Trade." The letters he has sent home are ably written and quite interesting. We subjoin a few extracts:

I left Boston, on the fourth day after my arrival in America, for the city of Lowell, whence I am writing. The first thing that struck me upon entering the town, or, as every place with more than ten thousand inhabitants is called in America, the city, was the absence of any building resembling cotton factories. I walked past the end of one of them, situated in one of the main streets, and it was not until the next day that I knew it to be a mill. The mills are usually situated in streets made shady and picturesque by a row of trees on each side, and the buildings are in themselves so handsome and imposing as to add to rather than take away from the pleasant appearance of the city. The fact of the factories being almost entirely driven by water-power, and that anthracite coal is used, renders the atmosphere clear and the buildings free from that smoky, grimy appearance which is characteristic of English manufacturing towns.

Nearly the whole of the cotton mills of New England are the property of joint stock limited companies, or, as they are called here, "Corporations." They differ, I believe, in one respect from most of our English public companies, inasmuch as the stock of shares are held in comparatively few hands, and have generally come down from the original founders to their present descendants. The management of the mills is nominally in the hands of a Board of Directors, but they meet only occasionally, perhaps once in three months. The buying of the cotton, the selling of the goods, and the general superintendence, are in the hands of the "Treasurer," at Boston; but in many cases the selling is done by a commission house, in Boston or New York, who act in a capacity similar to that of yarn and cloth commission agents in Manchester. The management of the factory is in the hands of the "agent," who resides near the mill and who has the general supervision of the works and property. The mills here are large, and as the agents have absolute control, they are well paid, their position is an honorable one, and such as is usually occupied by gentlemen of ability and high character. The Merrimac Corporation was founded in 1822, and as at that time the State of Massachusetts was almost entirely agricultural, it was necessary to make arrangements in order to prevail upon the farmers' daughters of New England to forsake their rustic labor for the more remunerative occupation to be found in the factory.

In order to effect this, and also because it was thought to be the right course to follow, the Merrimac Corporation built good, substantial three-storied houses, and put each of them under the care of a matron of respectable character, with whom the daughters of the farmers might board, and where their parents might feel that their children were as safe as under the paternal roof. Churches and chapels were also built by the various corporations as they were found to be required, and the workers in the factories were bound to attend with regularity some place of worship each Sunday. To a certain extent, a modification of this system still continues to be the rule in Massachusetts, Maine, and New Hampshire; in Connecticut it is common, but not universal. All the corporations in the three first-named States are owners of houses, about one-half of which are now let as boarding houses. The rents are fixed at a low rate, on the understanding that the workpeople shall be lodged and boarded at the following fixed rates: Young women (per week) $1.75, or 7s. 3d.; men (per week) $2.75, or 11s. 6d. The boarding house keepers are allowed by the corporations, in addition to the amount paid by young women, 50 cents, or 15d. per week, for each young woman who boards with them. These terms are for lodging and three meals a day, and as there is considerable competition for boarders the tables are usually amply supplied, and complaints are seldom heard. Men and women are lodged in separate houses, except occasionally, when a married couple are allowed to live in one of the female boarding establishments.

This system, as has been said previously, applies only to about one-half of the houses owned by the corporations; the other half are let in flats to families at moderate rents, and those of the working people who cannot obtain accommodation in the houses belonging to their respective mills make their homes in the wooden cottages which are scattered round the outskirts of the city. The result of this plan is that the corporations appear to occupy a more patriarchal position toward their workpeople than is the case in England; they seem to take an interest in their moral welfare, and in so far as it lies in their power they protect them against temptations of various kinds. The net result appears about the same as that arrived at by our English plan. Being discharged is, however, a practical demonstration of the disadvantages of an indulgence in vice. Not only is extreme severity exercised towards those who are known to be guilty of drunkenness, etc., but the corporations are also careful to prevent their employés from joining any trades unions, or other combinations for self-protection. There have, in consequence been but few contentions between the workpeople and their employers in Lowell, and, with the exception of one or two temporary combinations among the mule spinners, the existence of trades unionism is unknown.

The hours of labor in Massachusetts are fewer than in the States of Maine, Rhode Island, New Hampshire, and Connecticut. In the four latter States the hours are sixty-four and a-half per week; in Massachusetts only sixty. The week in Lowell is made up as follows: Monday, Tuesday, Wednesday, Thursday, and Friday, 6:45 to 12:0, and 1:0 to 6:0; Saturdays, 6:45 to 12:0, and 1:0 to 4:30.

In Maine, Rhode Island, New Hampshire, and Connecticut, the working hours are as follows: Monday, Tuesday, Wednesday, Thursday, and Friday, 6:30 to 12:0, and 1:0 to 6:30; Saturdays, 6:30 to 12:0, and 1:0 to 5:0.

CONSTRUCTION OF AMERICAN COTTON MILLS.

Writing from Fall River he says: The construction of American mills differs considerably from what is considered best in England. In Great Britain a spinning and weaving mill would be thought to be best adapted to its purpose if it consisted of one large brick or stone block, made fire-proof by iron beams and pillars and brick or concrete arches, in which to carry on the processes of preparing and spinning the cotton. The weaving would be done in a single storied building, lighted from the top, such as we designate "a shed." In America such methods of mill construction are practically unknown. The main beams, the floors, and, I believe, in some cases the pillars of the American mills are of wood. The woodwork is, however, much stronger than is usual in English buildings, the pitch pine beams measuring, I should judge, about 15 in. by 22 in. The floors are made of 3 in. planks laid at right angles to the principals; upon this foundation there is laid a hard wood floor, 1¼ in. thick, while underneath the planks are neatly cased with V jointed woodwork, thus forming a handsome ceiling. The staircases are also of wood, and are usually built spirally, the towers up which they wind being 12 ft. or 15 ft. in diameter, and forming a handsome feature in the external architecture of the mills. The looms are generally placed in the second and third stories of the factories, and on account of the great heat of summer and the extreme cold of winter, the process of weaving is rarely carried on in sheds. With such a kind of mill construction an English cotton spinner would associate ideas of fire and of large amounts paid for insurance against loss by its ravages. In America, however, insurance is not costly, and I found on comparison that an American mill would cost little more for insurance than an average fireproof mill in England. My information was gained by comparing the cost per lb. of yarn produced. This comparatively low rate of premium is, no doubt, to a great extent owing to the excellent construction of the American mills, to the great precautions taken against the commencement of fire, and to the extraordinary preparations made for its extinction should it break out. From the ceiling of each room in the mills here are hung perforated pipes.

If a fire occurs in any part of the mill a man has only to run down to the factory yard, where there is a small building, with a sign over the door marked "Sprinklers." This building contains a number of valves, each labeled with the number or name of a room. The man has only to open the valve indicating the room he desires to flood with water, and immediately a shower bath commences its downpour upon the flames. Every inch of the room, from ceiling to floor, is subjected to its influence; and if the fire has not laid serious hold its extinction is a matter of certainty. In addition to this method of grappling with fire, the arrangements of the hose pipes are most complete, and every portion of the mill buildings can be reached from the outside. In some of the cities the factories are connected with each other by pipes in such a manner as to allow the whole power of the combined steam engines or water wheels of the various mills to operate with their pumps upon the particular mill where a fire is raging. This has the effect of preventing loss by fire through a deficiency of pressure in the water pipes. The telegraph communicates from every street corner with the central fire station of the city, and thus a fire has far less chance of becoming serious than with the more defective appliances and slower methods of communication general in England. The greatest care is exercised in the mills, and at all of them one or more watchmen are employed, not only at night, but during the meal times and on Sunday.

A watchman's clock usually stands in the office of the mill, and this communicates by electricity with every room. Strips of paper marked with the hours, half hours, and quarters are evolved from the clock; and upon these an electrical apparatus indelibly impresses the time at which the watchman has put his finger upon the communicator while upon his rounds. A watch is always kept when the workpeople are absent from the rooms, and thus no portion of the factory can be left uncared for except with the knowledge of those whose interest it is to preserve it from destruction. There is no doubt that the result of these precautions is that there are fewer serious fires in the American than in the English mills, and, therefore, I think that it would be well if English millowners and insurance companies would pay some attention to the matter of fire prevention as practiced in America.

The very great care exercised in the mills of America to preserve the most absolute cleanliness is one of the facts that strikes a stranger forcibly. The floors are thoroughly washed each week with soap and water, and the mills generally present an appearance of tidiness such as is rarely seen in English factories. The same may be said of the workpeople, who never have the dirty uncared for look which, especially in the large towns, is unfortunately so common in Lancashire. In Fall River there is, I think, a greater resemblance to what we see in the English cotton manufacturing districts, but even here there is a marked superiority over the Lancashire people in regard to every-day cleanliness and respectability of appearance. The young women resemble the dressmaking class more than the factory hands of England. I should say that on the whole the sanitary condition of the American mill people is superior to that of their fellows in Great Britain. This is partially owing to the fact that the mills in the United States are usually of more modern construction than those in England, and the difference, therefore, though to be regretted, is unavoidable.

COST OF BUILDING AMERICAN COTTON MILLS.

Regarding the cost of mill construction and of machinery in America, I found that a considerable difference of opinion existed in different districts and among different people. As it is in the United States a universal rule to spin and weave under the same roof, the cost of a mill and machinery is always calculated so as to include the building and all machinery necessary for the converting of cotton into cloth. In Fall River, where the mule is generally employed for spinning both warps and weft (filling), the cost of a factory is estimated at about $13, or 54s. 2d. per spindle; this amount, of course, includes the cost of the looms necessary for weaving the production of the spindles into calico. This price is considerably less than what it has been, for many of the mills in Fall River have cost not less than $22, or 91s. 8d. per spindle. The estimate I found most generally adopted where the warp yarn is spun on ring frames, and the weft, or filling, on mules, is now $15, or 62s. 6d. per spindle. I calculate that a spinning and weaving factory in England would cost to-day about $7, or 29s. 2d. per spindle. The above calculations are for medium counts of yarn, and your readers will, of course, understand that the cost will vary as the yarns become finer or coarser. It seems perhaps a little extraordinary that such a difference should exist between the cost of mills in England and the United States. Timber and stone are both cheaper across the Atlantic than in Great Britain, and both of these materials enter largely into the construction of American mills. Skilled labor is, however, much dearer, and, as I said in my letter of the 1st inst., a very good price is obtained for American made machinery. I should think its cost is about 70 per cent. higher than similar machinery of a better quality made in England. The high protective duty gives English machine makers but little chance of competing. It will be obvious that the great expense incurred in building American factories must be a very serious burden upon the backs of those who care to work them, and that in this respect they labor under a very serious disadvantage as compared with their rivals in England.

THE REPAIR SHOPS.

I found that it was difficult to compare the cost of production in England and America, and this, for one reason, because of the difference in the cost of mills and machinery. It is, of course, easy enough to work out the sum if the figures upon which it should be based are obtainable. In no instance did I find that any account was kept of the depreciation of buildings, plant, or machinery. The plan the mill managers say they adopt is that of keeping up everything in a thorough state of efficiency; they replace the different parts of a machine as they become worn, and they say that thus the depreciation of machinery is shown in the shape of bills for iron and brass, and in the wages paid in the mechanics', or, as they call them, the "repair shops." If something of this kind is not done, there are, without doubt, many more mechanics employed in the American mills than would be considered either necessary or desirable in similar establishments in England. I was astonished at the size of the "repair shops" in some of the mills, for they were larger than the works of many a respectable machine maker in England. The tools they contained were the best obtainable, consisting of screw and wheel cutting machines, upright drills, enormous planing machines, and great slide lathes, besides a large variety of smaller tools of the best construction. The number of mechanics employed were frequently as high as a hundred and fifty, and in more than one case there were two hundred. At many of the mills tinmen and spindle and flier makers are employed. My American friends must not think that I do not hesitate before I say that I believe they are mistaken in adopting this elaborate system of repairs. I am inclined to think they would do better to trust more to their machine makers and less to their own individual mechanical skill. There is, of course, not at present quite as great convenience with regard to the proximity of little repairing shops as we have in England, but this want would supply itself as it was found to be required. In addition to the foregoing considerations, I may say that I am quite convinced that machinery depreciates in value as much by being superannuated as by being worn out. Where a machine is cast on one side in order to supersede it by another of an improved construction, it is obvious that every penny has been wasted that has been expended upon it in order to prolong its existence. The system of repairs adopted in America has, I believe, from what I saw in the mills there, a decidedly bad influence, inasmuch as the machines are sometimes kept at work, on account of their perfect state of repair, when it would be far better that they should have been replaced by others of more modern construction. The same mistake is, no doubt, sometimes committed in England, but it is by no means so common now as formerly, fierce competition having made it impossible for old machinery or methods of manufacture to stand against improvements in construction and modern ideas of management.

TAXES.

There is little doubt that the taxation of Fall River is higher than its inhabitants can at present well afford to pay. Preparations had been made by the local authorities for a very rapid increase in the size of the city when the period of depression commenced some years ago, and the expectations then entertained have not been realized. The taxable value of Fall River is now less than it has been since 1872, while for the past four or five years taxation has steadily increased so as to stand at its present high level of $18 per $1,000. To an English reader this may not appear to be a very high rate, but it must be remembered that taxation and rates are in America levied upon machinery as well as upon the buildings of the mill, the amount of the tax for $1,000 being charged upon the gross value, and not, as in England, upon the annual value of the property. The result of this is that a mill of 40,000 spindles in Fall River pays in rates and taxes as much per year as $11,000, or £2,290. A similar mill in England would, I suppose, pay about $1,200, or £250. The amount paid in Fall river is considerably higher than in most of the American cities; in Lowell, for instance, a mill of 42,000 spindles pays only $8,800, or £833, while in Rhode Island the rate will not exceed seven dollars per thousand. In the amounts paid are included the Government and State taxes and city rates; but, in addition, the shareholders of the corporations have to pay an income tax upon the dividends they receive.

CHARACTER OF THE WORKING POPULATION.

It is not, however, in the matter of taxes only that Fall River has had to suffer. Its working population is more largely composed of English people than that of any other American city; and these have brought with them their Old World ideas regarding the benefits of trades unions and the profitableness of strikes. The history of Fall River is that of a series of labor disputes, and this fact has had not a little to do with the suffering that has been experienced. I was informed by a man who has worked continuously at one of the best mills here, that during the last ten years there have only been two years during which full time has been worked; the greater part of this lost time had been caused by contentions about wages. I am sorry to say that English cotton factory workers are not generally liked in America. They are considered to be skillful and capable of turning out a large quantity of work, but their discontent renders them less satisfactory in the long run than the more reliable and persevering natives of other countries.

Reverting to the subject of the time worked in American mills, I may observe that there are fewer holidays here than in England, and there is no period of rest corresponding with our wakes. The only play day are one day in April, the Fourth of July, a day in November, and Christmas day. In all four days during the year. I suppose it is a fact that men will do things out of England they would refuse to do, and think themselves very badly used to be asked to do at home. There is little doubt that this is one reason why people succeed out here who have been previously unsuccessful. Of the people who work in the mills, a very large number are of Irish extraction. The nationalities are represented by about fifty per cent. of Irish people, twenty-five per cent. of French Canadians and English, and twenty-five per cent. of native Americans. In walking round the outskirts of Lowell, you cannot fail to be struck with the fact that nine out of every ten small storekeepers or liquor dealers are Irishmen, nor is it difficult to recognize their features as they pass along the streets. Even in the machine shops most of the mechanics are Irish. Without saying anything deprecatory of Irish character, I think it will be acknowledged that the bent of Irish genius is not in the direction of mechanics, and I understand that even here they are not considered to be gifted with peculiar fitness for this kind of work. I should say that a good "all-round" English mechanic, such a one as has been brought up in a mill, would earn first-rate wages here; that is, if he would be steady, and would leave behind him his ideas regarding the working of only fifty-four hours per week.

HOURS OF LABOR.

With regard to the hours of labor in American mills, they are 66 hours per week in Rhode Island, Maine, and New Hampshire; 72 hours in Connecticut. In Massachusetts the hours are 60 per week. The Legislative Assemblies of the various States of the Union have each the power of controlling factory labor in their respective districts; as, indeed, they have also the management of many matters such as are in England regulated by Parliament.

STEAM *vs.* WATER POWER IN AMERICAN COTTON MANUFACTURE.

I said in my last letter that the cotton factories of Lowell were driven almost entirely by water power. The same may be said of most of the American cotton mills. Fall River is, indeed, a place of steam engines, and it is also the largest center of American cotton manufacturing, but in regard to its motive power it is an exception to the rule. Upon the face of the matter, it appears to be a considerable advantage to have the water of a great river, the free gift of Heaven, flowing through the factory yard, apparently giving costless motion to the surrounding machinery. I have heard English travelers declare that England cannot compete with a country possessing so great a natural advantage as this. It is undoubtedly a great power, and is intrinsically economical. It will never become exhausted, and its owners enjoy a present monopoly of which it is not probable they will be deprived. This cannot be said of the use of coal, and on this account it appears to be probable that the industries requiring motive power will eventually follow the course of the great rivers of the world. At present, however, I cannot say that the employment of water is generally considered by the American millowners to be more economical than the use of coal. Those who own the water rights of a great river, with its weirs, canals, and locks, of course make use of their possession, but if you ask them whether, with the present improved steam engines, the task of damming up the rivers would be again undertaken, they generally express the opinion that the steam engine would be adopted in preference to water. In most cases the waterworks have been constructed by the men of a bygone generation, who discovered to their sorrow that they had made a sacrifice of their pecuniary interests for the public good. The old proprietors have usually been bought out by the present occupiers at a price very far below the original cost, and it is therefore difficult to ascertain what is the amount upon which interest ought to be calculated if the real cost of motive power in America is to be ascertained. The usual reply to an inquiry as to the original expense of bringing water to the mills is that it has cost a great deal of money, no one knows how much. We may, therefore, I think, without being very far wrong, say that at present our American cousins enjoy but little advantage from their water power. I had occasion to make a comparison between the cost of power in an English mill worked by steam with a mill of similar size, making similar goods, in Rhode Island, worked by water. The agent of the Rhode Island mill could not tell me the exact amount the waterworks had cost, although they had been constructed and were owned by the proprietors of the factory, but he said that they had not cost less than $70,000, or £14,580. Upon this amount interest at the usual rate of 6 per cent. is $4,200, or £875 per year. This amount includes nothing for repairs, of which I could not ascertain the expense. At the English mill the annual expense for coal and teaming, and this includes the cost of heating the mill and sizing, was $4,338 or £900. In the price of fuel we have a very decided advantage in England, where it will not be far wrong to put down the present average price of engine coal laid down in the factory yard, at $1.50, or 5s. per ton. In New England, whither the coal has to be brought from Pennsylvania, the price is $4, or 16s. 8d. On the other hand, the average American steam engine is a less voracious creature than its English contemporary, a little less than two pounds of coal per indicated horse power per hour being in most cases all that is consumed. There is room for improvement in England with regard to the consumption of fuel, and it would, I think, be well if English manufacturers were to take a step in this direction, while iron and labor are cheap and before coal again becomes dear. Before leaving the question of motive power I ought to say that it must not be forgotten that in many places in America, among which are Manchester, Lawrence, and Holyoke, the rivers have been dammed up, the canals have been dug, and all has been made ready for the building of mills. The water power lies ready for any one who likes to use it, and there is no doubt that those who take their factories to the water mill have an advantage in the cost of motive power. I need scarcely say that the old-fashioned water wheel has been superseded by the turbine, some forms of which are said to be capable of utilizing as much as eighty-seven per cent. of the water power. Motion is communicated from the turbines or steam engines in the American mills to the machinery by leather straps or bands. There are a few mills where gearing is used, but practically it is unknown. I must say that I was very favorably impressed by the satisfactory results obtained, and I do not wonder that band driving is considered preferable to the plan usual in English mills. There seems to be almost perfect immunity from break downs, and there is certainly an entire absence of noise and vibrations. The bands wear for a very long time, and give scarcely any trouble. I saw a belt four feet wide and two hundred and sixty feet long that had turned four hundred horse power for twenty years, and was still in excellent condition. I have no hesitation in saying that the days of gearing are numbered, and that eventually either bands or ropes will become the universal method of communicating power.

THE IMPROVEMENTS SCIENCE CAN EFFECT IN OUR TRADES, AND IN THE CONDITION OF OUR WORKMEN.*

By PROFESSOR W. E. AYRTON.

TRADE is bad, horribly bad! The causes of this depression, which meets us on every side, it is not difficult to ascertain—inability to compete with the foreigner in the production of what England consumes, combined with inability to trade economically in his own markets. We cannot, for example, now grow corn or rear cattle as economically as we can get them from America; so that while our land produces ten million quarters of wheat a year, we import as much as thirteen millions, whereas thirty years ago we grew fourteen millions (more, in fact, than at present), and imported only four million quarters per annum.

On the other hand, the Americans can manufacture machinery cheaper than we can sell it to them, in consequence of their high import duty of about 50 per cent.

We might say that this state of things arose from their having on the other side of the Atlantic vast pasture lands, a good climate, and protection; while we are cramped for room, inundated with rain, and luxuriate in the blessings of free trade.

It is not, however, only the demand abroad for English commodities that we see slowly dying away; but we find that even in our own country we are being gradually undersold in those productions which depend not on pasture lands, not on climate, but on the use of labor-saving machinery—the result of human ingenuity.

Our disappointment in witnessing the gradual disappearance of the foreign market for our manufactures may possibly be alleviated by our belief that the example we are setting of perfect freedom in trade will be ultimately for the world's good. But no ray of consolation can cheer the remembrance that our Coventry ribbon trade, that once famous industry created by ourselves, has well-nigh departed to Switzerland in company with the silk-weaving industry of Lyons and Spitalfields. The Clerkenwell mechanic sees with no feeling of national pride the American ma-

* The inaugural address, delivered at the City and Guilds of London Institute, Nov. 1, 1879.

chine-made watches pressing on his heels in the march of time. Even our trade in the bending of umbrella and stick handles is rapidly crossing the Atlantic, and several of our chemical industries are being absorbed by the continent.

And what about those devices, those Yankee notions, as we call them, in which machinery replaces the old cumbersome and uneconomical hand labor—the sewing machine; the type writer, for clear and rapid correspondence; the electric pen, for superseding lithography; duplex and quadruplex systems of telegraphy, for multiplying the carrying capacity of a telegraph line; and that instrument for dispensing even with messengers, the telephone? Why, not only do these come to us now from America, but it was in that country that they all sprang into existence, with many brothers and sisters like themselves. I shall, no doubt, be answered that it was to that country that they all owed their birth, because American labor is so dear, and, consequently, some means must be found to economize it. You might imagine from this there was in America a national evil—dear labor—and that machinery had to be devised to overcome its ill effects. But do high wages necessarily mean large selling prices of manufactured goods? What foreman in this room, wishing to turn out articles well and cheaply, would prefer employing an ignorant Indian laborer, at say twopence a day wages, instead of an English mechanic, with his knowledge of tools, at six shillings a day? So, in the same way, a highly paid American workman may, with his most ingenious labor-saving machinery, undersell the English in their own market. One of the things, therefore, which England requires, in order to regain her old commercial supremacy, is smaller cost of production of manufactured articles, a condition of things which, I think, you see is not at all incompatible with higher wages.

In my British Association lecture to the workmen of Sheffield this year, I have experimentally shown how an enormous economy can be effected in the consumption of coal, and, consquently, in the cost of generating power, and in the working of the metals, as well as in the expense of warming and lighting your buildings, by the employment of very large steam engines and of natural sources of power, such as streams and waterfalls, and by conveying, through the agency of electricity, this power to the distant places where it was required to be used. For water power, if sufficiently far away from a town, is often worth little or nothing, since the cost of conveying the work done on the spot over the hilly country to the markets more than compensates for the economy of using water instead of steam; but the waterfall, if utilized for transmitting power into the towns by electric currents, becomes much more economical than burning coal. Again, as I explained to my audience, work done by distributed power from a very large steam engine would be much cheaper than using a number of small steam engines, if only the power could be distributed without the great waste which always accompanies the friction of shafting, leather belts, tooth wheels, etc. Now, if by means of what is called a dynamo-electric machine, we convert the work done by the one large steam engine into electricity on the spot, and convey, by means of wires, this electric current to different points, and there with dynamo machines worked backwards we reconvert it into motive power, then the loss of energy by friction, etc., can, with the special form of working I explained, be reduced to something like thirty per cent.

As a small illustration of what I mean, I will show you the following experiment: When I turn the handle of this machine my muscular energy is converted into electricity; the food that I have eaten is burnt up in my body, and its equivalent—a current of electricity—is produced. This electric current, by means of the copper wires before you, is conveyed across the hall to that other machine, similar to the one I have here. In that distant machine the electric current is converted back again into mechanical motion, and the work given out there can be practically made use of—for turning, for example, that sewing machine.

In the same way, but on a much larger scale, we ground knives on the platform of the Albert Hall, Sheffield, turned a lathe, sawed thick planks, electroplated, and lighted the building, the power for doing this being all supplied by a steam engine a quarter of a mile away. Coal was put into the furnace of the steam engine at one end of the long copper wires, and work was given out at the other ends of the wires in the Albert Hall.

But the importance of this principle of the electric transmission of energy, like that of many other simple principles, while grasped by foreign engineers, is almost unknown to the British public. Last year, in order to gain the advantage of plowing by steam, while at the same time to avoid the disadvantage of pulling a heavy steam engine into rough fields, two French engineers, MM. Chrétien and Felix, plowed by electricity. A plow was used having two sets of shears, so that it could be used going forward or backward without turning. This plow was pulled across the field, first one way and then the other, by dynamo-electric machines, stationed one on each side of the field. These dynamo-electric machines were driven alternately by an electric current, conveyed to them by wires coming from a third dynamo-electric machine on the hard road some hundreds of yards away, and to which motion was given by a steam engine placed beside it. A photograph, taken on the spot, of the plow and one of the dynamo machines, I now project on the screen.

We will next look at a second photograph of a drawing of M. Chrétien's electric crane for unloading boats. This also has been successfully employed for several months in the harbor of Sermaize, France, and it is considered that a saving of about thirty per cent. has been effected in the expense formerly incurred for unloading the sugar barrels out of the boats.

When one of our leading telegraph engineers, Dr. Siemens, had urged so strongly the economy of this electric transmission of power, it may appear inconsistent for me to say that the British public do not realize in the least the value of this new principle, and needless for us to fear that their conservatism will throw considerable obstacles in the way of its general adoption; but then we must remember that Dr. Siemens is a German, and was probably educated in a German Polytechnicon, or in some institution realizing the value of technical education, and affording the means for imparting it.

At Sheffield it was the economy of utilizing the present wasted natural sources of power that exist in our mountain streams that I urged on my large audience; to-night it is the utilization of even a still more important dormant natural source of power—man's brain—that demands our close attention.

It must sometimes have puzzled you why a successful professional man, one who has no manual skill, no strength of limb, earns by his work so much money, and what is higher, so much fame. It must sometimes have struck you as, at the very least, rather hard that while you are toiling from morning to night, day after day, to gain only enough to live on, another, by the mere efforts of his thought, amasses a fortune. But you, no doubt, regard it as quite fair that a skilled mechanic should receive higher wages than a navvy. For you say that although he has eyes and arms, like yourself, and is, perhaps, the stronger of the two, still you can use your powers with a skill of which he knows nothing. Now, just as he has muscular strength, which, when cultivated, means wealth to himself and his country, so you have brain power, which only requires education to fit it to do useful work. But you will say, Am I not forgetting you have all been to school, and have received an education at least as good as is given in the board schools? Consider, however, what is taught in these schools where masses have to be educated. Is there time to teach reflection, to foster the reasoning power? Is there that training given you which should make you unwilling to follow any special routine method in your trade, unless you are convinced it cannot be improved on? And can you expect it to be otherwise, when the boys and girls leave at 12 or 13 years old, when the main object of the teacher, who is paid by results, is to cram the young until they are heavy enough to drop through the examining machine, when occasionally the teaching is necessarily confined to the three R's, solely because the Government inspector finds that other subjects are—well, a little beyond his limited attainments? Again, what is the feeling boys and girls have at the national schools? If they succeed in their lessons they look forward to becoming pupil-teachers; but if prizes do not fall to their share, they feel that teaching is not for them, and fall back on a trade; but how very few, if any, ever look to their studies as a means of making them educated workmen, instead of mere copying machines!

The consequence is that, when a lad is first apprenticed, he is merely an errand boy, or fag, being fit, in fact, for little else. Subsequently he is posted in one of the departments of the manufactory, his instructor being the man under whom he works; but this man, having his own work to attend to, has not time to teach, and, even were it not so, he could only show the boy the manual operations.

When the piece of work on which the apprentice has been engaged is finished it has to pass the foreman of the department; generally a man who, through honesty, sobriety, and manipulative skill, has risen from the ranks of the workmen, and whose education has been of a character similar to those around him. The foreman's duties, of course, leave him no time—even if he were competent—to give instruction, and thus the lad goes on, probably working, quite mechanically, at only one small branch of his trade. In time he becomes a journeyman; he may become a foreman, to govern others. Thus the "rule of thumb"—viz., each man working as his shopmates do—proceeds, and thus ignorance of principle has been carried on from one generation to another. And things go on remaining very much as they are, merely because we have never seen them otherwise.

The man, or woman, then, instead of becoming an agent far above any machine—in that there should be the possession of the reasoning power, which is a quality of no machine—frequently finds him or herself, mentally, infinitely inferior to Babbage's calculating engine: bodily, quite unable to work with the accuracy and speed of, say, an automatic lathe for turning gunstocks; and, from having a knowledge of only one narrow department of one restricted industry, is quite at the mercy of the fluctuation of trade for the means of subsistence.

But, do not let it for the moment be thought that I am regretting the Education Act of 1870, or am in the least blaming the necessary course taken by the school boards, since nobody is more alive than they are themselves to the incompleteness of the present education of the English artisan. That may be seen from this year's report of the Educational Endowments Committee, in which it is recommended that the city parochial charities shall be employed for the establishment of technical schools, to be attended by boys and girls for the two years after leaving the existing schools, that is, during their fifteenth and sixteenth years. It is not necessary on the present occasion to refer to the suggested curiculum of such technical schools beyond saying that it appears to be complete.

It ought to be tolerably clear to every man that it is important for him to have a good knowledge of the fundamental principles that govern the processes employed in his own trade. For example, when it is remembered what great mechanical differences are produced in iron by the admixture of even small quantities of carbon, and by varying the temperature of hardening and annealing, the steel manufacturer will see at once the importance of the study of chemistry to him. In these pieces of steel which I hold in my hand, and which are all quite soft now, the smallest amount of carbon is less than one-tenth per cent. and the largest amount only one and a-half per cent., but if I heat all three pieces red hot, and plunge them into cold water, the first, you see, remains quite soft, while the second has become springy, but the third is glass-hard, so that it shivers to pieces when I try to bend it. But if I had kept them heated white hot for some time I should have burnt out the carbon, removed the steely nature, and spoilt them. If, again, after heating the specimens of steel red hot, I had cooled them very slowly, they would, as you all know, have been found each of them quite soft as they were originally.

Now many of us believe steel is far better for our bridges than iron, but the fact that such very slight differences in the chemical composition and the mode of cooling change so marvelously the mechanical strength, without materially altering the weight or the general external appearance of the material, renders any system of testing the quality of the completed girders a difficult problem, and so while on the one hand we are still chary of using steel for bridge purposes, on the other hand the chief manufacturers and chemists are closely turning their attention to the difficult problem of producing steel in large quantities of identically the same chemical and mechanical quality throughout.

So, in the same way, a man engaged in telegraphy, or in any of the various trades connected with electricity, understands the importance to himself of a knowledge of electricity, for he has such facts constantly forced on him as that the difference of the hundredth of an inch in the position of a wire means the difference between a telegraph line in good working order and a total interruption. For example, this electro-magnet which we have on the table has now the power of holding up masses of nails, because an electric current is flowing round its two arms; but if I make a breach in the wire, and keep the two ends separated by even an exceedingly small distance, or if I even press the ends together leaving, however, a bit of paper or some dirt between them, the electric current is so much weakened that the electro-magnet, as you see, has practically quite lost its power.

Or, again, such facts that metals expand when heated, as you see does this brass ball, so that it will not pass through the brass ring it slipped through when cold, are of importance to every wheelwright, to every caster in metals, etc.

But something more than mere special knowledge is of importance to each man, for the object of education is to develop the mental powers; the acquisition of knowledge I regard as of but quite a secondary importance. Let a man but acquire the art of learning one subject properly, and the groundwork of his education is to a great extent completed, since he will naturally afterwards be always seeking for knowledge from books, from teachers, from nature, in all those branches which at any time may be of importance to him.

THE GROUNDWORK OF EDUCATION.

It is of much importance that a correct notion of the real aim of education should be impressed on you to-night, when we are here to inaugurate the commencement of that wide scheme of technical education which the city and guilds of London have, after mature deliberation, generously seen fit now to enter on. In the future we hope to have special classes for a variety of technical subjects, and we shall look to you, guided by your own wants, to choose for us, to a great extent, what those subjects shall be; but, just for the present, we must be contented with only a few branches of technical education. Do not, however, run away with the mistaken notion that because I commence my first course of lectures on Monday next in this building, on "Some of the Practical Applications of Electricity and Magnetism," that, therefore, if you are a watchmaker, or if you are a boiler-fitter, or if you are a coach-builder, you can have no concern with what will be taught. Do not say, I shall never put up an electric bell; and, as for electric lights, why in these hard times I have hardly money enough to pay for tallow candles. If I were merely going to explain to you how an electric bell was made, and how it could be fitted up in the cheapest and, commercially, best way; or if, again, in my lectures after Christmas, on "The Elementary Principles of Mechanics, as exemplified in our Clocks and Watches," I was merely going to tell you more dodgy ways of making cheaper watches, you might well say, if your particular trade was not concerned, "That's no good to me," and stay away. But when I tell you that from the wide range of technical physical subjects from which the choice had to be made, electricity was selected to start with because it was a subject that had been so prominently before you of late, and the mechanical science of watches has been advertised to follow it, because a watch is a machine you nearly all of you possess, and can, therefore, examine for yourselves; and when I assure you that the fundamental truths that will be elucidated by experiments from these branches of inquiry will be of no less importance in the advancement of carpentry, printing, and turning than for improvements in electroplating, watch making, and the allied trades, you will see that coming to these lectures is a duty you owe to yourselves and to your country, and you will conclude, I hope, very many of you, that "since the city is generous enough to offer its money to help my education, I have ambition enough to come and learn."

I have said that the main object of education is the mental training which it insures, and, as a proof of how very much more important this is than any mere accumulation of facts, may be seen from so many inventions having been made by minds which, although educated, had but a small knowledge of the special details of the science to which the invention belonged. Take, for example, the Bell telephone; it was not any very extensive acquaintance with electrical apparatus that enabled Prof. Bell to invent this apparatus. Nor, again, was it a wide knowledge of the laws of acoustics that led Mr. Edison to successfully devise the first practical talking machine, the phonograph. And, thirdly, it was not any special knowledge of telegraphy that led Mr. Cowper to invent his "writing-telegraphy," and similarly with several other discoveries.

We may say that the invention of the Bell telephone depended on the inventor, during his investigations of the experimental methods of determining the natural pitch of vowel sounds, seeing that magneto-electricity (that is, the generation of an electric current by the motion of a magnet near a coil of wire) realized, as Sir William Thomson puts it, "the mathematical conception that, if electricity is to convey all the delicacies of quality which distinguish articulate speech, the strength of its current must vary continuously, and, as nearly as may be, in simple proportion to the velocity of a particle of air engaged in constituting the sound."

Magneto-electricity, as you no doubt all know, was discovered by Faraday, and is one of the most beautiful examples of the importance of studying elementary principles. Faraday was not a student at a university, spending money and time in learning the conventional accomplishments of a gentleman, but he was the son of a blacksmith who had, by hard work, to earn his own living. I have no time now (I wish I had) to tell you about the life of that one of England's heroes who spent it in fighting against and vanquishing scientific difficulties in order that the world might add to its possessions a new and unknown land of scientific discoveries. But I will say just one word about this discovery of magneto-electricity, since on it depends all the electric lighting of the present day, and all the electric transmission of power—that vital question of the future.

Faraday knew that motion could produce electricity with the ordinary glass electrical machine, and that the electricity so produced could in its turn set up motion, as in the pith ball telegraph worked by Sir Francis Ronalds. He knew that difference of temperature could produce an electric current, and the electric current could in its turn produce heat, or difference of temperature. Consequently Faraday felt sure that, since an electric current can, as you have seen, produce a magnet, a magnet must, in some way, be able to create an electric current. But his attempts were baffled time after time; failure, failure, only was the result; yet, buoyed up with hope, still persevering with that dogged earnestness which is the characteristic of an Englishman, he at length arrived at this all-important discovery—to produce a current with a magnet it is no use placing the magnet this way or that way relatively to the coil, but you must have *motion* of the one relatively to the other.

Here we have a vertical copper wire, up or down which we can send an electric current produced by a battery outside the room. Behind the wire there is a magnet, suspended on a horizontal axis, so that it can turn in a vertical plane. The magnet is so arranged that usually it stands upright, but if I send a current upwards, you observe this end turns to your left, while if I reverse the direction of

the current the same end now turns to your right, the magnet in both cases placing itself at right angles to the wire.

Such an arrangement then is a detecter of a current, but it is rather a rough one, and only indicates the presence and direction of large currents. But this other instrument, in which the wire goes many times round the suspended needle, is more sensitive, and as the deflection of the magnet is indicated by the motion of a beam of light reflected from a small piece of looking glass stuck on the magnet, the presence of very small currents may be detected. To the two ends of the wire forming the current detecter are attached the two ends of the wire forming this coil. The spot of light is now in the center of the scale, indicating the magnet is undeflected, or that no electric current is passing; but if I rapidly move toward the coil this magnet which I hold in my hand, the spot of light is deflected to the left, and then comes back to the zero position, indicating that an instantaneous electric current was set up in one direction. Now, if I rapidly remove the magnet I have in my hand, you observe that the spot of light swings to the right and then comes back to zero, indicating an instantaneous electric current in the opposite direction.

When Faraday first made this discovery, in 1831, I have no doubt many people thought it a very pretty scientific experiment, but not likely to be of any practical use. Yet to what a host of practical purposes has it been applied during the last forty years. We now see that the invention of the galvanic battery, such as we are using for producing the electric light in this hall, is beginning to sink in importance before magneto-electric induction; for how do we get those strong currents to produce the electric lights of the present day on the Thames Embankment, Waterloo Bridge, the British Museum, or nearer still, in Aldersgate station? By magneto-electric induction. How do we get these sparks with this Ruhmkorff coil which enables us to imitate lightning on a small scale, and so to devise by experiment lightning protectors for our telegraph lines? By magneto-electric induction.

Magneto-electric induction is used not only in the Bell telephone (one of which you now hear on this table giving out the ticking of that clock by the aid of Hughes microphone, and another of which you see employed with this Hughes induction balance, by means of which two grains of gold can be detected in a pound of silver, solely by the slight electrical change so small an admixture of gold produces throughout the whole mass), not only, I say, is Faraday's principle of magneto-electric induction employed in all these wonders, but it is made use of in the Edison loud-speaking telephone which you now all hear telling you the words spoken to it by a man in a house in Tabernacle Row.

But, besides magneto-electric induction, Mr. Edison employs two other most ingenious principles in order to fulfill the necessary condition of every instrument used for electrically transmitting human speech, viz., that the strength of the electric current must be nearly proportional to the velocity of the particle of air engaged in constituting the sound. The first of these principles, discovered by him in 1872, is, that the passage of electricity, from one body to another resting on it, diminishes, in certain cases, the friction between them, and allows slipping to take place more easily if they are pulled one over the other. For example, if I am pressing a piece of platinum attached to the zinc pole of a battery, as in the figure, on to a piece of paper moistened with a dilute solution of hydrogen disodic phosphate, and attached to the copper pole of the battery, then if a pulling force be applied to the paper, a little less than that necessary to make it slip, it will be found that slipping will take place whenever the key is pressed down, so that the electric current is allowed to flow, and the paper will stop again each time the circuit is broken, so that the current is stopped. Already this principle has enabled Mr. Edison to convert his motograph or telegraph-receiving instrument without electro-magnets, and, it may possibly be found to have some connection with the comparative inefficiency of railway brakes when skidding takes place, that is, when the rotation of the wheels is entirely stopped.

But most important of all, Mr. Edison, by means of it, was enabled to devise his "loud speaking telephone," when the Bell Telephone Company would not allow him to make use of theirs. Inside this instrument there is a cylinder of compressed chalk, *a*, in a figure, moistened with the liquid I have already referred to. *c* is pressed on to the chalk cylinder, so that when the chalk cylinder is rotated, *c* is, by friction, pulled a little onwards, and the diaphragm is stretched. If, now, an electric current coming from the distant station, passes from the strip, *c*, to the revolving chalk cylinder, *a*, the friction is lessened and the diaphragm springs back, and thus swingings of the diaphragm are set up exactly in time with the alterations in the strength of the electric current.

But how does Mr. Edison make these variations of strength of the current time with the sound waves emitted from the speaker's mouth? By utilizing another very pretty principle—that carbon opposes less resistance to the passage of an electric current, becomes, so to say, more porous to electricity, if you squeeze it. A galvanic battery sends a current through a piece of pressed carbon at the speaking end, and the sound waves emitted by the speaker's voice strikes this carbon and press it more or less, making the current stronger or weaker.

Next, let me draw your attention to the American Stock Printing Telegraph, of which we have specimens in this hall receiving and printing messages sent from a house in Tabernacle Row. This instrument, in that the paper is started running, the message is printed, and the paper stopped again when the message is finished, all by electric currents coming from the distant station, and without any control of any kind at the receiving end, may be looked upon as wonderful, even for an American invention.

Look again at Cowper's writing telegraph, some specimens of the production of which are now handed round the room. It is a well known principle that any motion along a plane may be regarded as the result of two motions at right angles to one another; any motion of a fly, for example, crawling along a wall is so much movement up or down, combined with so much movement sideways. With these two levers working at right angles to one another, and conjointly moving a pencil, I can write what I like, or, if properly controlled for me by these cams, they will write definite letters, in this case, "W. T.," Mr. Cowper's initials. This idea is employed in defining the position of a place on the earth's surface by its latitude and longitude; it constitutes the whole of the science called *analytical geometry*, which has been of so much service in all branches of modern scientific advance. And yet it does not seem to have occurred to telegraph engineers that all ordinary writing can be compounded of two motions at right angles to the two edges of the paper, and, by well-known electric principles, can be exactly reproduced and compounded at a distance, producing a *facsimile* at one end of the line of what simultaneously is written at the other. Technical education being what it is, it is not surprising that this electrical invention should have been made by a mechanical engineer and not by an electrician.

IMPORTANCE OF A GENERAL KNOWLEDGE OF PRINCIPLES.

We might, did time only allow, go on multiplying indefinitely examples to prove that a *general* knowledge of elementary principles is of the greatest importance to every man, whatever be his trade. George Stephenson, but a coal miner, and yet the practical inventor of the present locomotive engine, understood that fully. No institution for the advancement of technical education was founded for him, no city companies lent him a helping hand, and yet he set himself to study the principles of mechanics when he had only just succeeded, with great difficulty, from his absence of leisure and instruction, in teaching himself to read and write, as he sat by the engine fire. The account of his experiments to discover a form of miner's safety lamp is a living exemplification of the rule attributed to Bacon, but, in reality, given long before by the painter Leonardo da Vinci: "Begin with observation, go on with experiments, and, supported by both, try to find a law and a cause." Starting with his own idea that, in order to prevent fire-damp exploding, it was necessary that the gas should pass through the lamp at a certain velocity, Stephenson arrived, after many experiments, at the all-important result, discovered quite independently by Sir Humphry Davy, that wire gauze, if the meshes are of sufficient fineness, cuts, as you see, a mass of gas into two portions, one of which can be ignited without the other catching fire or exploding.

And realizing so fully as he did the advantages of education, it is not to be wondered at, that he strained every nerve to have his son Robert well taught, and even sent him to Edinburgh University, where, in six months, he is said to have acquired as much knowledge as takes many ordinary students three years to learn. And why to Edinburgh University, and not to some nearer English college? Because, at that time, there was no institution where the means of a man like George Stephenson, only one step removed in position from that of an ordinary miner, could obtain even a decent scientific education.

And what has been the result of this cheap and general Scotch education spread over many years? Why, that we now see so many posts at home and abroad held by Scotchmen, just as we find a considerable portion of the more important positions in our manufactures occupied by young Germans, solely on account of the scientific training they have received.

What were the feelings Professor Bell had when in England? He wrote to America: "If you want to know why inventors are more numerous in America than they are in England, come and live for six months in England. If you wish to know what it is to be brimful of ideas, and yet to be unable to have them executed, come to England. Masters, instead of encouraging invention, do all they can to put a stop to it, by charging the most exorbitant prices for experimental work, avowedly because they don't want such kind of work, because it gives, they say, more trouble than it is worth," and much more of the same nature.

Now granted, if you like, that this is much exaggerated, granted, even if you wish, that it arose from national prejudice, still we must remember that Bell himself was an Englishman, and the inventor of one of the most wonderful instruments of modern times. Also, we must not forget that George Stephenson's attempt to survey the route for the Liverpool and Lancashire Railway led to his being frequently stoned by the inhabitants of the property, who have since most largely benefited from his work; and that Sir Francis Ronalds' letter to the Secretary of the English Admiralty, in 1816, describing the electric telegraph that Sir Francis had constructed and successfully worked, led to an answer, splendidly calculated to foster invention, viz.: "Mr. Barrow presents his compliments to Mr. Ronalds, and acquaints him, with reference to his note of the 3d instant, that telegraphs of any kind are wholly unnecessary, and that no other than the one now in use" (that is, the semaphore) "will be adopted."

If England is, then, so lamentably deficient in technical education, how is it that English engineers, English workmen, have hitherto been considered first in the world? Because we started earliest in the race, because we had an abundant supply of coal and iron, and, lastly, because we had an indomitable energy; but Dr. Lyon Playfair, some years ago, asked this question, and the present depression in trade leads me to ask it again now: "Do you sincerely think that the country can continue in a career of prosperity, when she is the only leading state in Europe that is neglecting the higher education of the working classes, and of those men above them whose duty it is to superintend their labor? It is a truth incapable of being gainsaid, that science must be joined to practice in the advancing competition of the world, in order that a nation may retain the strength and energy of manhood; for states, like individuals, fall into decrepitude and decay." Dr. Lyon Playfair has been answered; answered sooner, and in a more decided manner, than even he could have feared; and that reply is, No! our country has, indeed, not continued in its former state of prosperity Years ago France, Germany, and, above all, Switzerland, set themselves the same question; but instead of waiting, like ourselves, for time to give the sad response, they foresaw it, and, by fostering technical education, have absorbed into their country some of the industries of the world. The city and canton of Zurich, having once grasped that their system of national education was defective in modern practical science, vied with each other in providing funds for the complete equipment and support of a technical university. They did not, as Mr. Scott Russell tells us, ask themselves "What is the smallest and least costly scale on which we can begin to make good a few technical deficiencies?" but they asked themselves that other question, "What is there in the science, the philosophy, the learning, the art, and the practical skill of modern times, which can be learnt and taught, but for which there is no adequate provision already made for teaching to our students in the universities of our land?"

And yet another nation, small and apart from the world, a people like the Swiss, dwelling in a mountainous country, and like them too dearly loving their pineclad hills—the Japanese—have set us an example that our ambition should lead us to emulate. Much have we heard of Japanese art, much have we seen of Japanese lacquer, Japanese fans, but only a few of us are acquainted with Japanese modern technical education. Ten years ago a feudal country, tyrannized over by barons, with power of life and death in their hands, distracted by the conflict between the rightful sovereign and their hereditary military usurper, that nation whom we regarded as barbarous, that nation of whose manners we were comparatively ignorant, whose very modes of thought are so different from our own that we can be hardly said to understand them now, that people had but three years emerged from a state of almost slavery, when up grew, in its very midst, a technical college, with its staff of carefully chosen English professors, with its laboratories, class-rooms, museums, libraries, and workshops, costing Japan, a poor country be it remembered, at least twelve thousand pounds a year to support, and many many thousands to build. And to enter and study at this college, neither money, nor position, nor any qualification is necessary but ability and desire to study; so that working at the lathe, or conning over their books in the class-room, or experimenting in the laboratory, may now be seen, side by side, the young noble and the young artisan.

An example to emulate, did I say? The city companies have given us the opportunity; let us show that we appreciate it. They do not propose merely to teach each man his trade or business, for that he can best learn in the workshop or counting-house, nor have they any idea of merely grounding you in elementary arithmetic, since that you can learn at school; they do not start by building handsome edifices, although they have subscribed many thousands for erecting in London a large central technical college, but what they have done is to henceforth put on one side more than fifteen thousand a year of their own money to give you from now that education which will enable you to commence doing what George Stephenson, in these words, half a century ago, urged on you: "Learn for yourselves, think for yourselves, make yourselves masters of principles, persevere, be industrious, and then there will be no fear for you."

STEREOSCOPES FOR LARGE PICTURES.

WHILE the stereoscopic slides in general use, and which were first introduced in the form they now assume to suit the Brewster or lenticular stereoscope, are exceedingly convenient, a desire has always been expressed that the principle of binocular vision could be practically applied to the examination of photographs greatly exceeding in dimensions those of the common stereoscopic slide.

But it is an outcome of that principle, when applied to vision through lenses, that the portions of a pair of pictures which are viewed stereoscopically shall not to any marked extent exceed the distance of the eyes apart. This, therefore, limits the dimensions of the binocular photograph, at least in the horizontal direction, although to the vertical dimensions there are no special limits—a fact attested by the introduction during recent years of slides possessing, in some instances, one-third more depth than those so long accepted as of standard dimensions. To admit of photographs of more than three inches in the horizontal direction being examined stereoscopically, it is necessary that reflectors be employed, and when this is the case there is no practical limit to the size of the pictures—a principle well known to those who are familiar with that little-known instrument, the Wheatstone reflecting stereoscope, of which the popular form of stereoscope introduced by Sir David Brewster is a refracting modification, both of a more convenient shape and (unlike the other) showing the pictures in a non-reversed form.

The problem of exhibiting binocular pictures of large dimensions has engaged the attention of several opticians and men of science, and no little ingenuity has been displayed in working it out. It was a favorite idea of the late Mr. Thomas Sutton to project side by side upon a large screen (by means of a pair of magic lanterns) the two views composing the complete slide, and then getting them brought into one by means of a pair of prismatic spectacles, which—a public entertainment or lecture being presupposed—were to be handed to each person present. So far as we recollect, he never submitted his idea to the test of experiment; but, as we have recently taken occasion to do so, we are in a position to state that the effect is sadly disappointing, the combined picture having quite a dwarfed appearance.

More ingenious is a method of applying the stereoscopic image to the purpose of public exhibition proposed some time since to the French Academy of Sciences by M. D'Almeida, and of which our readers may not be aware. By means of a pair of dissolving lanterns both images are thrown simultaneously upon the same disk. This, of course, would produce confusion in several parts; but a cap containing a red glass was placed upon the objective of one of the lanterns, a similar cap containing a green glass being attached to the other. The spectator now examined the jumbled picture on the disk through a pair of spectacles fitted, one eye with plain red and the other with plain green glass, with this result—that the eye protected with the green glass saw only the image projected from the green lantern, the red-covered eye doing the same for its color. The combined image, composed of the two colors—each complementary to the other—forms a true stereoscopic picture; not a very brilliant one, it is true, seeing that it is a union of red and green, but otherwise perfect. But we may dismiss the consideration of the best methods of adapting the principles of the stereoscope to public exhibitions—such being a comparatively valueless application—and consider the best and most recent means whereby large binocular pictures can be rendered available for individual examination.

Early in the present year a comprehensive paper on this subject was submitted to the Royal Dublin Society by Mr. Howard Grubb, who is well known to many of our readers to have devoted much attention to it, as the volume of the *British Journal of Photography* for 1873 fully attests. Without making any observations on the other 'new forms of stereoscopes" described to the learned society just named (some of which, by the way, have, unknown to Mr. Grubb, been previously suggested or manufactured), we cannot sufficiently express our admiration of the bold novelty of the *pièce de résistance* among the stereoscopes there described. Finding the impossibility of arranging two large pictures side by side, with a view to their being seen as a single picture in relief, Mr. Grubb conceived the idea of placing them one above the other, and then of devising adequate means by which one eye only of the spectator should be confined to one of the pair of pictures, the apparatus employed for effecting this end serving the purpose also of causing the axes of both eyes to have the same horizontal direction, and hence making the vision quite natural. Of this new application of the principle of binocular vision we purpose giving such details as shall enable every reader to comprehend thoroughly this, the latest, claimant for attention in the domain of photographic optical science.

Place flat on the table, and immediately in front of the observer, a picture of moderate dimensions—a 12×10 landscape, for example, although one need not be restricted to any special size; and while the eyes are directed horizon-

tally—in other words, "straight before him"—let the observer hold in front of his eyes a small hand mirror directed downward at an angle of 45°, and he will see therein reflected the photograph which lies on the table. If instead of a single mirror for both eyes he make use of two smaller mirrors, one for each eye, it will be found that by a slight motion of one of them two images of the picture are produced, and that by careful adjustment one of these may be made to join the other at its upper margin.

Now, Mr. Grubb's new stereoscope is just the very counterpart of this. It necessitates the employment of two pictures instead of one, these forming a binocular pair, and the two must be mounted so that the top margin of one is to the bottom of the other, instead of being side by side, as usual. The "eyepiece," through which this pair of pictures must be viewed, consists of two small mirrors—one opposite to each eye—these being adjusted to each other, by experiment, in such a manner that, when the pictures are examined, one of these pictures becomes displaced to such an extent that it falls upon or coincides with the other; and the union of the two images thus produced will form a single picture, the features of which stand out in all the bold relief of stereoscopic projection.

Although we have spoken of simple mirrors in describing the nature of this stereoscope for large pictures, the inventor naturally prefers to employ reflecting prisms, as giving a much more perfect image, although, in the principle of reflection, the mirror and prism are alike Of course the intelligent reader does not require to be told that when a piece of silvered looking glass is made use of to effect the purpose indicated it causes a secondary, or ghostly, image in addition to the principal image, owing to the first surface of the glass causing a reflection in addition to that effected more perfectly by the silvered surface behind.

It need scarcely be remarked that the photographs, when laid upon the "stage" of the new instrument for examination, must be placed in an inverted position when single mirrors or singly-reflecting prisms are employed, and for the same reason objects will be reversed as regards their position of right and left. However, by bringing to bear upon the subject some of the recognized refinements, either of optics or of photographic practice, these drawbacks, where deemed to be such, may easily be overcome.

When examined in a rough model of Mr. Grubb's new stereoscope, a pair of whole plate photographs of a group of three individuals were exhibited in a manner so satisfactory as to make us hope that this instrument will come into general use on account of its efficiency in connection with pictures of this class.

We shall, no doubt, be met with an objection having reference to the *production* of stereoscopic pictures of large dimensions, quite irrespective of the class of instrument by which they are to be eventually examined, whether Wheatstone's or Grubb's. But there are in existence at the present time "tens of thousands" of stereoscopic negatives of the usual small standard dimensions; and from these to produce prints enlarged to two or three diameters is by the collodion transfer process a feat requiring nothing but the most ordinary degree of skill.—*British Journal of Photography.*

MAGNETIC CIRCUITS IN DYNAMO AND MAGNETO ELECTRIC MACHINES.*

By LORD ELPHINSTONE AND CHARLES W. VINCENT, F.R.S.E., F.C.S., F.I.C.

THE experiments which form the subject of the present note were made in connection with an investigation as to the best form for the construction of a dynamo-electric machine, intended to furnish currents of high intensity in great quantity. The principle deduced applies equally to magneto-electric machines.

The source of power in all dynamo-electric machines being electro-magnets whose cores are already slightly magnetic, it appeared to us necessary to consider the conditions under which the initial force of such machines is best obtained.

For this purpose we made use of a U electro-magnet having a core of soft iron 2 inches in diameter and 36 inches long. The arms of the U were 4 inches apart. The exciting helices were two sheet copper reels, 12 inches long, fitting closely upon the uprights of the U, but readily removable. Each of these reels was coiled with 200 yards of No. 14 double covered copper wire.

Two cores of soft iron, of the same diameter, and each 12½ inches long, and which could be magnetized by the same helices, were also employed.

The principal armature was of soft iron, 8 inches in length, by 3 inches in width, and 1 inch thickness, rounded at the ends. Its face fitted approximately close to the poles of the U magnet, whose faces it completely covered when placed upon them.

Other armatures and magnets were employed, the form of which we propose to describe in a future paper.

The iron of which the U and the straight cores were made was found to be exceedingly plastic as regards molecular magnetic polarity. In a few seconds after the cessation of an electric current from twenty quart Bunsen cells acting through the above helices, they were incapable of attracting and holding even fine iron filings.

The U magnet tested with a suspended magnetic needle was found to retain some magnetic polarity after many days; in fact, it is doubtful if the magnetism ever entirely disappeared, except when the core was subjected to special treatment.

On the other hand, the straight cores lost their induced magnetism more rapidly, and when, having been demagnetized either by time or by the mode described further on, they were placed in the line of the magnetic dip, they showed poles in accordance therewith; and on reversing the position of the core, these poles were immediately reversed without its being necessary to resort to striking the bars or other means of putting them in a state of vibration. It was thus demonstrated to our minds that if iron of similar quality, and in this form, were made use of for the electro-magnet cores in a dynamo-electric machine, the initial force producing the electric currents of the machine could not be due to residual magnetism, but rather to the lines of magnetic force of the earth.

The current from four Bunsen cells sent round the U magnet fixed the armature so firmly that it could not be pulled, or even slid off, by the utmost exertion of one man's strength.

On breaking battery contact, if both poles were completely covered, a direct pull failed to separate armature and magnet. The armature could, however, though with difficulty, be slid off; the difficulty of movement greatly increasing as the edge of the poles was approached. For instance, on attempting to slide the armature off the north, the south, or both poles, the resistance became greater as the point of final communication between the poles through the moving armature was approached. This was found to be the case whatever time had passed between the rupture of contact and the first movement of the armature. (Sometimes many days elapsed.) In very many experiments it was found, moreover, that, provided neither pole had been completely uncovered, on sliding back the armature to its normal position, the magnet, which with its stand and coils weighed over 58 lb., could be lifted by it.

A current from four Bunsen cells almost momentary in duration, sufficiently magnetized the core to produce all the above effects.

If, while the current flowed round the U magnet, the armature rested on one pole only, it was of course strongly held; but on breaking contact it was at once set free, and fell off if not balanced, the magnetism of the U core immediately falling to its minimum, as shown by suspended test needles. If, however, the most minute point of connection existed between the armature and the other pole, in addition to its complete contact with the one it covered, it continued to be firmly held long after battery contact was broken.

In being thought that possibly the effects described were partly due to molecular attraction of the iron atoms when brought into close contact under magnetic stress, the poles were coated with a layer of tallow, but if this was sufficiently thin, the magnet could still be lifted by the armature after breaking battery contact. When the tallow was broken into small lumps, allowing light to be seen between magnet and armature, the same result was obtained.

Thus absolute metallic contact was found to be unnecessary for the retention of a considerable amount of magnetism by the U core and its armature, when in magnetic circuit. With a piece of writing paper interposed between the poles and armature, they were held together with great force long after battery contact was broken; but when the distance was increased by the interposition of cards, nails, or wires to $\frac{1}{16}$ of an inch, the residual attractive force was very much lessened. When the magnetic circuit becomes more open the residual magnetism dies away in about the same proportion as the attractive force of core and armature, whilst under the influence of the battery current, becomes less when the distance between them is increased.

Interposition of thick glazed note paper caused such a diminution of the residual magnetism that the magnet could no longer be lifted by the armature.

The experiment was varied by putting lengths of fine silk thread straight across between the armature and the magnet; in this, as in the former experiments, the armature was firmly held, and the magnet could be lifted by it. There was no point of actual metallic contact, and light could be seen over both magnetic fields, except at the thin lines where the silk threads were. The 58 lb. magnet, when lifted by the armature, was thus literally suspended in the air (like Mahomet's coffin) by the magnetism remaining in the almost closed circuit, and this long after the exciting electric current had ceased. (The experiments were made at intervals of four hours, twenty-four hours, three days, four days; the armature had always ultimately to be wrenched off.)

The same result was obtained with plates or slips of zinc, copper, platinum, silver, and aluminum foils, gutta percha, tissue, embroidery cotton, etc., and appeared to depend entirely on the distance between poles and armature, irrespective of the nature of the interposed body.

When the straight cores were placed on the poles of the U magnet, and a current passed round the latter, attraction ceased the moment the battery contact was broken; but if, while the current was passing, the armature was placed on the poles of the cores, the whole system was firmly held together, though the current no longer flowed.

There would appear to be no limit to the length of time during which the stored-up magnetic force exerts itself in such metallic circuits (closed, or nearly so) as are described above, for it was found that, after periods varying from one to fourteen days from the time of a momentary passage of an electric current round the cores, the attractive force was as great, or even greater, than at the first moment.

A small electro-magnet, U-shaped, with limbs 6 inches long, having a core of ¾ inch iron, and helices consisting of 4 layers of No. 16 covered copper wire, had for its armature a similar U core uncoiled. The uncoiled U was hung up, and the electro-magnet held beneath it, the poles of each being opposed; a current from four Bunsen cells was then sent through the coils for a few seconds. Not only did the electro-magnet (weighing, with its coils, several pounds) remain firmly attached to its armature, but the hanging on to it subsequently of 8 pounds additional weight failed to detach it.

A further proof of the large amount of magnetism held captive in a circuit thus closed was afforded by the following experiments. On connecting the ends of the wires from the helices with a galvanometer and resistance-coil, deflections varying from 40° to 90° were obtained with a resistance of 1,700 ohms in circuit each time the armature was forced away from the poles of the large U magnet, after the passage of a current from four cells of a few seconds' duration. By careful manipulation, sparks between the ends of the helix wires were also obtainable each time the closed magnetic circuit was opened. (In one case a week had elapsed betwixt the passage of the current and obtaining of the spark.)

In all these experiments, when the circuit was completely closed there was no external magnetism apparent, but on slightly breaking contact between the poles and armature, magnetic poles could be detected. Slight irregularities of the surfaces in contact likewise caused the development of poles.

A heavy magnetic needle 4 feet distant from the magnet, if deflected by the U magnet, uncovered by its armature 45°, would fall back to 5° when the current ceased. If the poles were now covered by the armature, the needle went to 0°. Passage of the current from four cells would now give a deflection of about 38°; on the current cessing the needle would come back to 0°, and rise again to 5° on removal of the armature, but if, instead of immediately pulling off the armature, the two ends of the wires of the helices were connected together, and then the armature was forced off, the needle would swing 20° and fall back to 5° very slowly (in about fifteen minutes).

If both poles of the U magnet were caused to be of the same name, and the armature placed upon them, there was no attraction after breaking battery contact.

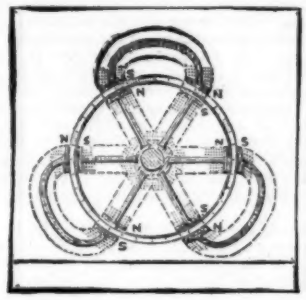
The straight cores, if placed upon the U magnet, connected by the armature, and then magnetized in such a way that the poles of the cores faced like poles of the U magnet, retained no magnetic polarity when taken away from the system, whereas when they formed part of such a closed circuit as we have above described, the bars retained sufficient polarity to affect a magnetic needle for some time.

We may here remark that the attractive force of electro-magnets for each other, in what we call open circuit, is not nearly as great as in a closed circuit. For instance, the U magnet could not be lifted by the straight cores placed upon its poles, even with a current from six Bunsen cells running round the helices; but on bridging the circuit with the armature the whole mass, weighing 82 lb., could be raised from the ground with the current of only two cells, and quite irrespective of the position of the exciting helices, whether both were on the magnet, both on the cores, or one on the magnet and one on the core.

From the foregoing experiments it appears clear that the more near the approach to a closed magnetic circuit, the stronger is the field of force, and the longer is retained the magnetism of the mass or masses of iron constituting the circuit. The same rule holds good with regard to permanent magnets. In closed circuits the attractive force is at its height, and diminishes in intensity as the magnetic field is more extended. But the parallel goes beyond this, for the more open the magnetic field, the more rapidly is the magnetic force itself dissipated.

These principles have guided us in the construction of a dynamo-electric machine of whose magnetic circuits we here present a sketch, and which we hope to describe more fully in a future paper.

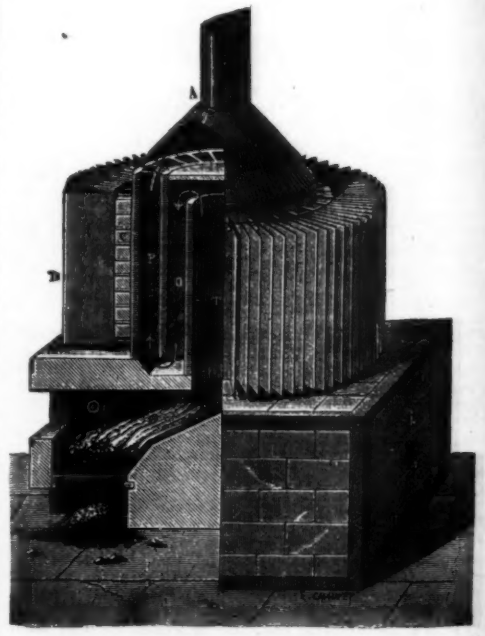
In the accompanying diagram six fixed electro-magnets are



shown, having alternate poles, opposite to which, and at a very short distance, are placed three other electro-magnets so arranged with opposing poles as to form three nearly closed circuits. Coils of wire are made to revolve so as to cross the intervals between these opposing poles, and the electric currents induced in the moving coils are made to pass round the electro-magnets.

CLAMOND'S THERMO-ELECTRIC PILE.

WE present herewith an illustration of M. Clamond's thermo-electric battery. A few months ago the inventor announced that he had succeeded in obviating the inconveniences attending batteries of this kind that have hitherto been employed, by forming his apparatus of three entirely distinct parts: (1) of a collector; (2) of a diffuser; and (3) of a thermo-electric system constructed in chains. These different systems have been realized in the apparatus represented in the annexed cut, the arrangement of which, however, may be varied. In this apparatus, the collector, which is formed of a cast-iron cage, T O P, somewhat resembles a smoothing-iron heater. Beneath it is a fireplace, F, in which coke is burned. The cage is arranged in such a way that the current of hot air, which is to produce the calcrific effects, may, after making three revolutions around the apparatus through the spaces, T O P, escape through the draught-flue,



CLAMOND'S THERMO-ELECTRIC PILE.

A, and then, by means of properly arranged pipes, be utilized for warming a room. Externally, the cage forms a polyhedral surface with a large number of faces, and to which are fitted the thermo-electric piles, C, arranged, as will be seen, in chains: and it is outside of these chains that are affixed the diffusers or coolers, D. The latter are formed of copper plates, arranged like the leaves of a book, and are soldered to flat bands of the same metal which are bolted closely to the chains. These plates, by reason of their great amount of surface in contact with the external air, radiate a considerable portion of the heat which is communicated to them, and consequently cause a relative cooling, which renders the temperatures of the opposite solderings of the thermo-electric elements more different. It is the presence of these diffusers that has made it possible to reduce the length of each thermo-electric element without inconvenience. It will,

* Abstract of a paper presented to the Royal Society.

moreover, be readily understood that these diffusers, by reason of their great radiating surface, can furnish a large amount of heat, and thus render the apparatus susceptible of being used as a stove for warming an apartment. The thermo-electric elements are arranged, as we have seen, so as to form real chains, and they have the appearance as shown at C, in the figure. The negative elements, instead of forming small elongated prisms of an alloy of zinc and antimony, are reduced to small, slightly flattened cubes 3 by 2 centimeters in size. These little cubes are united by strips of sheet-tin bent Z-shape, and their extremities are soldered to the opposite faces of the two contiguous elements. The strips are inclosed between the joints formed by the juxtaposition of the cubes; and in order to keep them from touching the latter they are covered with asbestos paper. The portions of the strips that are soldered to the cubes are cut so as to form a species of teeth, which are bent into the shape of a helix, thus insuring a perfect contact with the alloys to which they are soldered. These chains are very easily constructed, for they may be cast all at once in any desired length, all that is necessary being to place the series of Z-shaped tin strips between two cast iron rules and flow the melted alloy over all. Those portions of the strips that are covered with asbestos paper then separate the elements without any attention having to be paid to them. These chains, pressed between the collector and diffuser (from both of which they are properly insulated) may be connected together by their free extremities, thus allowing all the couplings and combinations that are desired to be effected at will.

A CHLORIDE OF LIME BATTERY.

By ALFRED NIAUDET.

THIS battery has for its positive electrode a plate of zinc, and for its negative electrode a rod of carbon surrounded by fragments of the same material.

The zinc is plunged into a solution of common salt; the carbon is placed in chloride of lime contained in a porous cell of either porcelain, canvas, or parchment paper.

The chloride of lime is, as is well known, a mixture of hypochlorous acid and lime; the acid seems well suited for depolarizing the negative electrode, because its two component parts can both of them combine with hydrogen to form, on the one hand, water, and on the other hand, chlorohydric acid. This acid can attack the zinc and produce chloride of zinc; or it can attack the lime and produce chloride of calcium. These two salts are very soluble, and very good conductors of electricity. The choice of the substances employed is such that the combinations which take place are soluble and conductive. It is possible that certain double salts are formed, as is the case in all batteries; but if this is the case they are soluble, as experiments with the batteries show.

The zinc in the presence of the chloride of lime is not sensibly attacked, and consequently batteries with these elements can remain for an indefinite period without waste; action only commences when the circuit is closed. This property is, as is well known, of great importance in many cases.

We will now consider the reason for employing chloride of sodium; the advantage is, that it is the cheapest of all salts without exception. The solution is the best liquid conductor known. But there is still another advantage; a great number of other salts and other liquids have been tried, notably sal-ammoniac, the hypochlorite of soda highly concentrated, the chloride of lime, diluted sulphuric acid, but all have given less satisfactory results and a lower electromotive force than common salt. The reasons of these inferiorities are undoubtedly very various; the defect appears to arise from the formation of an insoluble sulphate of lime which stops the further action of the battery.

The electro motive force of the new battery is found by experiment to have a maximum value of 1·6 volts, which falls to 1·5 after several months' use.

The depolarization produced by the chloride of lime is not complete or instantaneous, as it is in sulphate of copper batteries; if the battery is worked through a low external resistance the electromotive force falls, as is the case with almost all batteries. But this force regains its normal value quickly. In an experiment, the electromotive force being found to be equal to 1·39, the circuit was closed through a resistance of one ohm for forty minutes, the force was then found to be reduced to 1·13, but at the end of forty minutes, the circuit being open, it had risen to 1·29, and in two hours to 1·38.

The internal resistance of the battery is comparatively low, great care having been taken to reduce it as much as possible. The zinc is placed very near to the porous oil, and completely surrounds it, but is prevented from touching by a simple device.

The smell of the chloride of lime is hardly sensible even with the ordinary batteries, because care is taken to seal the porous cell, at its upper part, with asphalt, which protects the salt from the air and at the same time keeps it securely in the cell. The outer cell can also, if necessary, be hermetically sealed, as is sometimes done with other batteries.

THE NEUTRALIZATION OF PHOSPHORUS IN STEEL AND STEEL LIKE METALS.*

By Mr. RICHARD BROWN, Ayr, N.B.

As is well known to the members of the Iron and Steel Institute, the great difficulty in hitherto working up into steel the large class of ores and metals of iron in this and other countries is the large percentage of phosphorus which they contain, rendering the metals, when made up into steel, cold short. The aim, therefore, has been to get rid of the injurious element by elimination, but the close affinity that phosphorus has for iron has hitherto proved an almost insurmountable barrier. Some of the more recent processes are reported to have given good results, and if so, they are certainly a move in the right direction. Instead, however, of endeavoring to get rid of what I may call the great "enemy" of the steel trade, I have given my attention to the practicability of turning the "enemy into a friend," and in this respect I am glad to be able to announce that I have succeeded to the utmost of my expectations.

As is well known, the proportion of phosphorus that can at present, as a rule, be allowed to remain in steel is exceedingly small, something like 0·03 to 0·05 per cent. I am aware that larger percentages have occasionally been got, but they are the exception; whereas, by my process, I have been and am able to neutralize nearly as much as 1·5 per cent., still leaving the metal soft and malleable. I need not tell the members of the Iron and Steel Institute that in having made this achievement a very great point has been attained, which will lead to lasting benefits for the classes of ores and metals containing much phosphorus, hitherto unable to be used for steel on that account.

The agent I employ is bichromate of potash, a substance which is chemically pure, contains no water of crystallization, and is not deliquescent. It is, of course, well known that alloys of chromium and chrome ores have been used for hardening and fluxing purposes, but as a rule without success, as analyses of so-called chrome steel, made by processes hitherto used, have shown that such processes have been extremely uncertain, and in many cases altogether ineffective in combining chromium with iron or steel. By my process, however, there is no difficulty in effecting the desired combination, as the bichromate of potash has the very important practical advantage over what has previously been used of being a convenient, expeditious, certain, and effective means of introducing the chromium into the metal, be it iron or steel.

So far as I have gone with my experiments, I have found that to neutralize three-quarters per cent. of phosphorus about one-half per cent. of bichromate is sufficient. The percentage of phosphorus in "Scotch" pig iron is something like three-quarters per cent., and in that of "Cleveland" about one and a half per cent. If it is thought desirable, a mixture of the two metals, "Scotch" and "Cleveland," in the proportion of one-half of each, would give a metal containing about 1·1 per cent. of phosphorus, which again could be further reduced by the assistance of purer pig iron or malleable iron scrap. This would lessen the quantity of bichromate to be used with "Cleveland" iron.

Another very important advantage to be gained by the neutralization of phosphorus is the important one that castings made by this process are very solid and free from blowholes or small cavities, so that steel castings can now be adapted to almost any purpose, which, to the practical engineer, machine makers, and for railway bridges is of the very utmost importance. A further important improvement consists in the fact that there is little or no loss of metal going off in the slag by this process. When the material is used the slag is generally of a fine gray color, showing no black oxide of iron, as I understand is usually the case by the methods at present in use, and which, I believe, amount to a very considerable percentage of loss, thereby adding to the cost of the steel. In carrying out the process in practice, nothing can be simpler. No new plant is required or alterations necessary; all that is demanded being that the little details should be gone about carefully. I have found from experience that it is the little points which, when not attended to, often cause failures, but, when well looked after, result in success.

In the Bessemer converter the bichromate of potash should be mixed with the melted metal. It may either be added by being blown in as powder by the blast, through a small hopper communicating with the pipe by a descending passage fitted with two valves, the material being first admitted into the space between the valves, and after closing the upper valve allowed to descend gradually by opening the lower valve; or the material may be introduced into the metal from the mouth of the converter, the blast being stopped during its introduction and afterward renewed for a short time in order to effect a thorough mixture. When adding the material in a reverberatory furnace or other vessel, it may be in powder or in the usual crystals, put up in small handy paper bags, or other wrappers which will afford a slight protection while it is being introduced. During the time the material is being introduced the slag must be pushed and kept aside by means of an iron rod or other instrument, and the material should be well stirred through the molten metal. When the metal is in a crucible, the cover should be kept more or less open for a short time after adding the material in order to allow of the escape of gas, and the crucible should be kept in the furnace for a short time after closing the cover. While the material is being put into the converter, furnace, or crucible, and for a short time afterward, a slight ebullition takes place.

The quantity of bichromate of potash to be employed will vary in each case with the quantity of phosphorus present and the particular quality of steel desired. When the iron or metal to be operated on contains much carbon, the excess of carbon should be eliminated by means of the Bessemer converter or other adequate process before treating the metal with the material. For instance, with cast iron containing 0·75 per cent. of phosphorus and a variable quantity of carbon, the proportion of carbon should be reduced to about 0·2 per cent., and about 0·5 per cent. of bichromate should be mixed with the melted metal; this will yield a ductile steel. A larger proportion of bichromate of potash will give a harder steel. Only a portion of the phosphorus is in practice removed; but when the proportion of carbon is small, or is reduced as above directed, the phosphorus remaining in the metal no longer has an injurious action, nor imparts undesirable qualities, but, on the contrary, improves the metal, particularly by rendering it capable of being cast in a very solid condition and free from cavities or holes.

With a larger proportion of phosphorus present in the metal than that given in the above example, the steel will be harder, other things remaining the same. When the proportion of phosphorus is less than that given in the example, a larger proportion of carbon may be retained, and similar results got, with a smaller proportion of bichromate of potash. Therefore, to neutralize the effects of small percentages of phosphorus, only a very small quantity of bichromate of potash will be required.

In welding chrome steel a little attention is necessary. For instance, after the pieces have been brought to the welding point, instead of striking the pieces to be welded heavily with the hammer, the smith should only tap them gently with a small hammer until the pieces are slightly welded, after which a sledge or steam hammer may be used with perfect freedom, and unless this is attended to, there is a risk that the steel may fly into small pieces if heavy hammering is used at first. By attention to this almost any kind of my steel will weld, even should it contain large percentages of carbon and phosphorus.

I herewith exhibit a number of specimens of my steel, showing some welded, some made into chisels, and some bent and twisted cold, exhibiting their different properties. Underneath is their analysis, in part also their tensile strains.

	No. 1.				
Carbon combined	1·26 per cent.				
Chromium	0·25 "				
Phosphorus	0·78 "				
	No. 1a.	No. 2a.	No. 3a.	No. 4a.	
Carbon combined	0·190	0·180	0·230	0·200	per cent.
Chromium	0·180	0·200	0·210	0·320	"
Phosphorus	0·514	0·560	0·759	0·756	"
Tensile strain in tons per sq. in.	40·5	40·0	50·3	47·0	"
Ultimate extension per cent	4·61	24·0	5·7	4·74	"
	No. 1b.	No 2b.	No. 3b.	No. 4b.	
Carbon combined	0·30	0·30	0·53	0·41	per cent.
Chromium	0·14	0·16	0·20	0·26	"
Phosphorus	0·90	0·95	1·16	1·39	"
Tensile strain in tons per sq. in.	43·6	44·4	6·0	4·5	"
Ultimate extension per cent	19·35	8·19	..	..	"

The carbon in 3*b* and 4*b* is in excess of what it ought to be for a large percentage of phosphorus, and accounts for the low tensile strain. That, however, was caused by the difficulty I had in decarbonizing the metal, and which would not exist with proper and efficient plant, which I did not possess. I have, therefore, hitherto worked at great disadvantage in making these and all my experiments. With the carbon decreased there would be no difficulty in increasing the percentage of phosphorus to one and a half per cent. with good results.

I may be allowed to call the attention of the members to the fact that bichromate of potash has very great softening and toughening properties, and when used in connection with a steel containing a large percentage of carbon that it increases its ductility in a remarkable manner while retaining its tempering properties, with the addition of being easily welded, thus rendering it most suitable for work where great tensile strength is required, such as in ship building and railway bridges, especially bridges of large span like the one which is about to be erected across the river Forth. I exhibit a chisel marked No. 5; a piece of steel from the same material was tested, and gave the following results:

Carbon, 1·05 per cent.
Chromium, 0·27 per cent.
Breaking strain, 56·4 tons per square inch.
Extension, 4·6 per cent.

As regards phosphorus I believe there was very little present. In using a similar chisel, working with a sledge hammer, it ultimately bent to a considerable angle, and was afterward hammered back cold.

Mr. Brown, replying to the criticisms, said that the cost of the material would be about four shillings per ton to neutralize ¾ per cent. of phosphorus, but that practically it would cost nothing, taking into consideration the elements of phosphorus and chromium which were retained in the steel and the great saving in the metal which, by his process, did not pass off in the slag, as is usual by the present method. Then there was the great advantage of being able to use an iron containing phosphorus as against one which did not, and which latter were generally very high in price.

In working out the process it is best to begin with a small percentage of phosphorus—say ¼ per cent., and work up to a greater one.

* A paper read before the Iron and Steel Institute of Great Britain, September, 1879.

ON THE SEPARATION OF THE HEAVY METALS OF THE AMMONIUM SULPHIDE GROUP.

By CLEMENS ZIMMERMANN.

AFTER pointing out that the usual procedures are either very tedious or questionable as to accuracy, the author gives his method for separating zinc from the other metals of the group by means of ammonium sulphocyanide. To the liquid in question, which, in addition to the zinc salt, may contain any number of the other metals of the fourth group, iron and uranium, if present, being in the state of ferric and uranic salts, he adds, if its reaction is acid, carbonate of soda till a slight turbidity appears, neutrality being the main condition for success. An excess of a solution of ammonium sulphocyanide, not too dilute, is then added, the sides of the vessel are rinsed with water at 60° to 70°, preferably by means of an Erlenmeyer flask, and a very moderate stream of sulphureted hydrogen is introduced repeatedly, but not very long, till the odor of this gas does not disappear after the liquid has stood for some time. During the introduction of the gas the appearance of a milky-white precipitate is first perceived, and after a considerable time zinc sulphide is separated in flocks which continually become denser. The beaker is now exposed to a gentle heat till the precipitate has settled and the liquid has become clear, which may require six hours. It is then filtered, the white zinc sulphide is washed with water containing sulphureted hydrogen and ammonium sulphocyanide, and dried. This precipitate contains all the zinc, free from the other heavy metals of the group. When dry it may be ignited in a current of hydrogen according to Rose's process (*Poggendorff*, cx., 128), or it may be dissolved in hydrochloric acid, evaporated to dryness in a weighed platinum capsule on the water bath, mixed with an excess of elutriated mercuric oxide, pure, and free from alkali, evaporated to dryness, and ignited. Zinc oxide remains perfectly pure and without loss, and is weighed when cold.

In the filtrate from the zinc sulphide the sulphocyanides are first destroyed by means of nitric acid, which at the same time peroxidizes any ferrous or uranous salts present. This operation is best effected in a roomy long-necked flask, which is heated on the water bath, and nitric acid added by degrees in small portions until the liquid no longer becomes red followed by decoloration. Any yellow cyanogen persulphide formed is filtered off. If the acid is added too rapidly the liquid may be projected out of the flask.

In order to separate the iron present from nickel and cobalt, the solution, which may contain ferric salts along with nickelous or cobaltous salts or both, is mixed with an excess of ammonium sulphocyanide, when the blood-red color of iron sulphocyanide appears; a solution of "secondary" carbonate of soda is then added drop by drop, till the red color just disappears. All the iron is thus precipitated as ferric hydroxide, none of it remaining in solution, and no cobalt or nickel being thrown down. The precipitate is allowed to

settle, filtered, washed with boiling water to which a little ammonium sulphocyanide has been added, dried, ignited, and weighed. The filtrate is treated as has been directed for the filtrate from zinc sulphide. The author separates cobalt and nickel by Liebig's method with ferric oxide.

For the separation of iron and uranium, the liquid in which the metals must have been peroxidized is brought to a boil, mixed with an excess of ammonium sulphocyanide, and aqueous carbonate of soda is added, exactly as above directed for the separation of iron from cobalt and nickel. The same process is further followed for the removal of the iron, which is found free from the slightest trace of uranic compounds

The filtrate which contains uranic oxide in solution is first treated with nitric acid to destroy the sulphocyanogen, then neutralized with ammonia, and mixed with ammonium sulphocyanide; the precipitate of uranium oxy-sulphide is boiled, by which it is resolved into sulphur and uranous oxide, filtered, dried, and ignited. Lastly, the uranium is either weighed as uranoso-uranic oxide, or converted into uranous oxide by very strong ignition in a current of hydrogen gas which is maintained until the product is cool.

The precipitation of uranic oxide by ammonia is greatly promoted by the addition of ammonium chloride, without which it does not take place in dilute solutions.—*Annalen der Chemie.*

SILVER OXIDE FIRE.

By PROF. BOETTGER.

IF two measured parts of silver oxide, perfectly dry, are rubbed in a porcelain mortar with one part antimony sulphide, the mixture readily takes fire. The same phenomenon occurs if silver oxide is ground along with amorphous phosphorus. If a drop of phenol is thrown upon silver oxide the latter is partially reduced, with the projection of sparks. —*Polyt. Notizblatt.*

ON A NEW METHOD FOR THE SEPARATION OF NICKEL AND COBALT.

By M. PH. DIRVELL.

THIS method is founded on the following facts:

1. If there be added to the aqueous solution of cobalt nitrate or sulphate, an access of a cold saturated solution of phosphorus salt, mixed with a solution of ammonium bicarbonate from which no ammoniacal odor is emitted, a bluish precipitate is formed in the liquid. When the mixture is slowly warmed the equivalent of carbonic acid in excess at first escapes; then, by boiling for a few seconds, a very distinct ammoniacal odor is perceptible. At this moment the boiling is discontinued, and from 2 to 3 c.c. of ammonia added to the liquid. The precipitate is, for the most part, dissolved, and it is only necessary to warm gently to 100° to obtain a precipitate of a beautiful purple inclining to violet, which is rapidly deposited. Analysis assigns to this precipitate the formula $NH_4O,2CoO,PO_5+2HO$. It loses no ammonia at 110°, and is transformed at a red heat into pyrophosphate, $2CoO,PO_5$.

2. A solution of the corresponding salts of nickel, treated in the same manner, gives only a pure blue liquid, which is not rendered turbid by heat.

3. By mixing the two above mentioned reagents in excess with a solution containing cobalt and nickel, and treating in the same manner, the red precipitate of ammonio-cobaltic phosphate is again obtained, while the remaining blue liquor contains the whole of the nickel. By this means the cobalt in the nickel sulphate of commerce can be detected.

I find it better to make this separation for the qualitative research of the two metals in assay flasks, where evaporation is slow. For the quantitative separation I prepare my reagents in the following manner: 1·30 grms. of phosphorus salt are digested in the cold in 250 grms. of water; 2·30 grms. of effloresced carbonate of ammonia are dissolved in the same quantity of water, and the solution saturated with carbonic acid till all ammoniacal smell is gone.

After having separated the two oxides in the customary way, and having reduced them by hydrogen, they are weighed, dissolved in nitric acid, and the acid solution evaporated to dryness in a water bath. The residue is redissolved in about 50 c.c. of water, to which is added a quantity of phosphorus salt equal to thirty times the weight of the two metals, and to which a volume of ammonium bicarbonate equal to that occupied by the phosphate has previously been added. We then operate as has already been indicated, care being taken to frequently shake the flask containing the liquid, especially after the addition of the ammonia.

If the boiling has inadvertently been too prolonged, causing the evaporation of the blue liquid containing the nickel on the sides of the vessel, and the consequent precipitation of a little nickel, it is easily ascertained by the color of the cobalt precipitate, which will in this case be paler. It can also be compared with the moist ammonio-cobaltic phosphate, which is kept in a bottle to act as a test. In this case the clear blue liquor is drawn off, the red precipitate dissolved in only as much dilute phosphoric acid as is absolutely necessary (it is even better to leave a little precipitate undissolved), then the operation is continued with ammonium bicarbonate and ammonia.

In all cases the precipitate is washed in cold water, weighed on a tared filter at 100° or calcined; 100 parts of the calcined precipitate contain 40·4 of cobalt. With regard to the blue liquid separated by filtration, sulphureted hydrogen completely precipitates the nickel. The precipitate is calcined in a crucible with some sulphur and weighed in the state of sulphide.

This method is an exceedingly rapid one, for the separation requires only one or two hours at the most.*

In conclusion I would say that nickel sulphate now prepared with garnierite is found to contain magnesia, which affects the cobalt precipitate if the separation from that salt is attempted.—*Comptes Rendus.*

* M. Pisani, in whose laboratory this work was done, was kind enough to submit it to some analytical experiments, and he discovered that ammonium acetate could be substituted for the bicarbonate. The acetate is very simply prepared by saturating acetic acid at 8° with ammonia. Only 2 c.c. of this acetate is added, 0·060 grm. of cobalt, and 5 c.c. of the solution of microcosmic salt, prepared in the manner already indicated. In order to estimate the various quantities of cobalt in the solutions containing the two metals we rely on the following: A rose solution contains an excess of cobalt as compared with nickel; a brown solution, half of cobalt and half of nickel; a dirty green liquid, 1 of cobalt to 3 of nickel; and a green solution, 1 of cobalt to 4 of nickel. In the first case the acetate and phosphate are added as if all was nickel: in the last as if the liquid contained only a fourth part of nickel. After having heated the mixture of metals, phosphate, and acetate, for a few moments in the water bath, it is mixed with a little ammonia, and again heated in the water bath. At the end of a quarter of an hour the cobalt is precipitated. In cases where the precipitate has not the desired tint it is again treated as indicated above.

THE FUNCTION OF CHLOROPHYL.

THE Report of the Berlin Academy for July last contains a remarkable paper by Prof. Pringsheim on this subject. In pursuing his researches upon chlorophyl, he had found that positive results could only be obtained by employing *intense* light, and in this paper he gives some account of the conclusions at which he has been enabled to arrive by the use of this method.

By means of a heliostat and a strong lens, the object to be observed under the microscope is brightly and constantly illuminated; the effects of this illumination, which are striking, are produced in a few (3-6) minutes. Assuming that the object contains chlorophyl corpuscles, the first visible effect is the rapid disappearance of the green color, so that the object appears as if it had been lying for some days in alcohol, the corpuscles retaining, however, their form and consistence. Changes now gradually become apparent in the protoplasmic cell-contents; the circulation of the protoplasm, where it exists, is arrested; the bridles of protoplasm rupture, and the nucleus is displaced; the ectoplasm contracts, becomes permeable to coloring matters, and the turgidity of the cell disappears; the cell presents, in fact, all the symptoms of death.

It seems natural to suggest that these effects may be due, to some extent at least, to the action of the high temperature to which the cell is exposed under these conditions. Prof. Pringsheim, anticipating this criticism, is careful to point out that they are produced by all the different parts of the visible spectrum. They are quite evident when the light has previously passed through a solution of iodine in carbon disulphide, but they are more distinct when the light has passed through an ammoniacal solution of cupric oxide; the light to which the object is exposed consisting, in the former case, of red rays, in the latter, of blue and violet. Moreover, if the solution of iodine be so concentrated that only the rays of a greater wave length than 0·00061 mm. can pass, these effects are not produced, although about 80 per cent. of the heat is transmitted; on the other hand, if the ammoniacal solution of cupric oxide be so concentrated that the whole of the rays of low refrangibility to a wave length of 0·00051 mm. are absorbed, the effects are rapidly and vividly produced, although the amount of heat which passes is comparatively small. From these facts he concludes that the phenomena in question are the results not of the action of heat, but of that of light.

This important point being settled, he proceeds to determine in what manner this action of the intense light is affected by the atmosphere in which the object exists. As the result of a variety of experiments he finds that these effects are only produced when the atmosphere contains oxygen.

These are very briefly the facts which Prof. Pringsheim has ascertained by this method; we will at once pass to the consideration of the conclusions which he draws from them. He concludes, in the first place, that the decomposition (oxidation) of chlorophyl in the living plant is a process of combustion which is influenced and promoted by the action of light, and which stands in no relation to the decomposition of carbonic acid by the plant. Since the green color of the chlorophyl corpuscles which have become blanched is not subsequently restored, even though the cell continue to live, it appears that this oxidation of the chlorophyl is not a normal physiological occurrence, but that it is purely pathological. Prof. Pringsheim was unable to find any substance in the cells which might be regarded as the product of the oxidation of the chlorophyl, neither could he detect any increase of the fat or starch in the blanched cell, nor the formation of grape sugar or dextrin; he therefore concludes that the products of the oxidation of the chlorophyl are given off in the gaseous form. In the second place, he concludes that the changes produced in the protoplasmic cell-contents are the direct effects of the photochemical action of light. That they are not due to the presence of the products of the decomposed chlorophyl is shown by the fact that they may be observed equally well in cells which do not contain chlorophyl, such as the stinging-hairs of the nettle, etc. This being the case, he infers that they too are produced by a process of combustion. The final conclusion to which he comes is that chlorophyl exercises a protective influence over the protoplasmic cell-contents by absorbing the actinic rays of the spectrum, thus diminishing the combustion (respiration) going on in the cell; that it is in fact the regulator of the respiration.

In another series of experiments Prof. Pringsheim endeavors to determine what are the substances which become oxidized in the process of respiration. He finds in all chlorophyl-containing cells, a substance which can be best extracted by immersing the parts—leaves for instance—in dilute hydrochloric acid for several hours. This substance, to which he gives the name of hypochlorin or hypochromyl, is of an oily nature; it is probably a hydrocarbon which consists only of carbon and of hydrogen, or one which contains oxygen also in its molecule, but in smaller proportion than the carbohydrates; it is soluble in alcohol, ether, turpentine, and benzol, but insoluble in water and in solutions of neutral salts; it occurs in long, red-brown, crystalline needles, which soon harden after extraction, into an imperfectly crystalline mass of resinous or waxy consistence. It is readily oxidizable, as is shown by the fact that it disappears from the cell on exposure to intense light in an atmosphere containing oxygen even sooner than the chlorophyl. Prof. Pringsheim is of opinion that this substance is the first product of the assimilation of the chlorophyl-corpuscle, and that starch and oil are subsequently formed from it by oxidation.

Applying these views to the life of the cell under ordinary conditions, the changes going on in the cell when exposed in the air to sunlight would be somewhat as follows: The general protoplasm would undergo some amount of oxidation, but not so much as to materially diminish its quantity or affect its properties; in the chlorophyl corpuscles oxidation would be either entirely arrested in consequence of the absorption of the actinic rays by the green coloring matter, or at least so much diminished that the synthesis of the elements of water and carbonic acid to form hypochlorin could take place.

Since this paper is stated to be a merely provisional account of these very interesting experiments, it is hardly fair to submit it to a detailed criticism—it will be better to wait until the publication of the more complete account which Prof. Pringsheim promises in an early number of his *Jahrbücher*. All that will be attempted at present is to indicate some of the principal difficulties which beset the acceptance of these new views. For instance, exception may be taken to the view that chlorophyl, when exposed to intense light is oxidized into gaseous bodies. It is well known that an alcoholic solution of chlorophyl, when exposed to sunlight in the presence of air, becomes oxidized and assumes a pale yellow color; it may be that this also takes place in the chlorophyl corpuscles, the yellow color being hardly distinguishable on account of the smallness of the quantity which is present. Again, it will doubtless have occurred to every reader of this paper that hypochlorin may be nothing more than the wax which has long been known to exist in considerable quantity in chlorophyl corpuscles. But the main difficulty has reference to the protective functions which Prof. Pringsheim ascribes to chlorophyl. Admitting that the changes described above as occurring in the protoplasmic cell-contents are really the results of excessive oxidation consequent upon exposure to the intense light, it is evident that they are effected less quickly than the oxidation of the chlorophyl itself; that is to say that, *ceteris paribus*, the chlorophyl is more readily oxidized than the protoplasm. This being the case, it is not easy to understand how the former can efficiently protect the latter from the oxidizing influence of light and regulate its respiration. This difficulty might perhaps be met by the suggestion that fresh supplies of chlorophyl are continually being formed, but we have no knowledge yet at present of any such continual formation of chlorophyl; on the contrary, it is a well-established fact that when once the chlorophyl of a corpuscle is oxidized, it does not regain its green color.

It might perhaps be possible to obtain some further knowledge on this subject by observing the effects produced on cells by the action of strong light falling upon them, in some cases, directly, in others, after having passed through a solution of chlorophyl which would be renewed from time to time, if necessary. If it were found that, in the latter case, the cells remained uninjured, whereas in the former they soon died, some important evidence in favor of Prof. Pringsheim's views would be obtained. It might then be possible to extend these experiments and to bring about the formation of starch from carbonic acid and water in the cells of fungi, and even of animals, for Mr. Geddes' interesting observations on planarians show that animal as well as vegetable protoplasm is capable of effecting this synthesis.—*Sydney H. Vines, in Nature.*

HOULGRAVE'S GELATINE EMULSION.*

ONE of our most enthusiastic emulsion workers is Mr. George H. Johnson, Bridgeport, Conn., who, at this writing, is in the Adirondack woods, with camera and gun, making all the captures he can, health included. He took with him a new American Optical Company's 5 by 8 dry-plate camera, which he calls "the prettiest I ever saw." We hope to hear from him on his return. Meanwhile we publish the following for the use of emulsion workers.

In a recent letter to Mr. Johnson, Mr. Houlgrave, of Liverpool, England, gives further details in respect to the preparation of his gelatine emulsion as follows:

"In the first place let me explain that I always prepare my emulsion and plates in the evening, so that the times for performing the various operations are calculated for this. I employ the following utensils: two German glass beakers, one holding about four ounces, the other about half that quantity; an eight-ounce bottle with cork-lined stopper (glass stoppers are apt to stick); a tin canister with loose fitting lid, large enough to hold the bottle; a flat porcelain dish, seven inches by five inches; a tin tray about one and a half inches deep, and a little larger than the dish; an earthenware vessel with cover holding from six to eight quarts; a Bunsen burner, and a small spirit-lamp. I use Nelson's No. 1 photographic gelatine, as it does not require long soaking in cold water before it is ready to dissolve.

"It is quite essential that the bromide salts should be in excess, and for this reason I always test my materials before using them. Should this, however, be inconvenient, I should advise the use of rather less silver than I have prescribed in my formula; say 45 grains instead of 46 grains. In the larger beaker dissolve 26 grains bromide of ammonium in 7 drachms of water and 1 drachm of beer, and then add 10 grains of gelatine, pressing it under the fluid with a glass rod. Place the remaining 16 grains of gelatine in a separate vessel, and fill up with cold water. In the small beaker dissolve 45 grains nitrate of silver in 4 drachms of distilled water, and add three or four drops of dilute nitric acid (this is not necessary, but it helps greatly to keep the shadows clear).

"The beer above mentioned is prepared by mixing three ounces of ordinary bitter ale with one ounce of alcohol. This lasts a long time, and is always ready to use. The nitric acid solution is prepared by mixing one drachm of strong nitric acid with one ounce of water.

"Arrange the tin tray on any suitable support over the Bunsen burner; pour on water until it is about half an inch deep; place in the tray the eight-ounce bottle and the two beakers, and light the gas. Let the temperature rise to about 100° Fahrenheit, and then lower the flame. As soon as the gelatine in the beaker containing the ammonium and the beer is completely dissolved, pour into the same in one continuous stream the silver solution, at the same time stirring briskly with the glass rod. Transfer the emulsion just made to the eight-ounce bottle, rinse both beakers with a drachm of water, pouring it from one to the other, and finally into the bottle, and then give the emulsion a thoroughly good shaking. Next place the eight-ounce bottle containing the emulsion into the tin canister, into which a little hot water has been previously poured, loosen the bottle cork, and gradually raise the water in the canister to a boil over the gas burner (this should not require more than five minutes). Remove the light when the temperature of the emulsion has sunk to 100° Fah., add the remainder of the gelatine, having first drained off as much of the water as possible, shake gently, and keep the emulsion at a moderate heat for a short time longer, in order to allow time for any froth which may have been formed to subside; then pour the emulsion into the flat porcelain dish to set, place this on any level surface perfectly excluded from light, and leave it till the next morning. Then fill the earthenware vessel with cold water, and plunge into the same the flat porcelain dish containing emulsion, and cover up, letting it remain in a cool place till any convenient time in the evening, changing the water once an hour or so before using the emulsion.

"When ready to coat the plates, take a strip of tin or brass half an inch wide and bend it into the form of the letter V; place it in the tin tray; fill the latter with water enough to cover the brass strip, and place in the tin tray the porcelain dish containing the emulsion; heat the water with a lamp until the temperature is not less than 100° Fah.; now drop in ten drops of the chrome-alum and glycerine mixture, filter the emulsion through a piece of fine sponge into a beaker, having a mark at two ounces, and should the quantity fall short of this, make up with warm water. Next

* *Photographic Times.*

coat the plates, and place them on a perfectly level shelf, and not disturb them until quite dry.

"The beaker containing the emulsion should be kept in warm water while coating the plates.

"*Development.*—The ordinary well-known alkaline development succeeds with these plates very well, and for portraits it is the one which I use; but for landscapes I very much prefer the following, for which the below-mentioned solutions will be required:

"No. 1.—Put four ounces of good carbonate of ammonium into a pint bottle, and fill up with water (this will take a day or more to dissolve).

"No. 2.—Pyrogallic acid	60	grains.
Alcohol	1	ounce.
"No. 3.—Strong liquid ammonia	1	drachm.
Bromide of ammonia	5	grains.
Water	1	ounce.
"No. 4.—Alcohol	2	ounces.
Water	1	pint.

"Pour sufficient of No. 4 into a dish, plunge the plate to be developed into it, and let it remain there a minute or longer. Then mix the developer in the following proportions.

"One drachm of No. 1; two drachms No. 4; six drops No. 2. Pour this quickly on and off the plate a few times, and then add more pyrogallic acid solution. This should bring out the image in all its details; if it does not do so, drop in from five to ten drops of liquor ammonia (No 3). This will probably be sufficient; if not, rinse the plate with a small quantity of alcohol and mix a fresh developer, viz.:

Pyrogallic acid solution	5	drops.
Liquor ammonia	2	"
Dilute alcohol	1	drachm.

"Pour this on and off the plate, and add more liquor ammonia if required. Fix in moderately strong hyposulphite of soda (hypo, four ounces; water, one pint).

"Plates prepared and developed in this way are slow, the exposure with an ordinary landscape lens being from ten to thirty seconds; they are, however, extremely easy to prepare, are almost absolutely certain, and give the best results I have been able to obtain by the gelatine process.

"H. HOULGRAVE."

Formula referred to in above is as follows:

Gelatine	26	grains.
Bromide of ammonium	26	"
Nitrate of silver	46	"
Water	2	ounces.

Chrome-alum Mixture.—Dissolve twenty grains of chrome-alum in one ounce of water, and then add half an ounce of glycerine.

ON THE SOLUBILITY OF SOLIDS IN GASES. *

THIS investigation was undertaken in the hope that, by an examination of the conditions of liquid matter up to the "critical" point, sufficient knowledge might be gained to enable us to determine under what particular conditions liquids are dynamically comparable, in order that the micro-rheometrical method † (which the Royal Society has done one of us the honor of publishing in the "Philosophical Transactions") might be applied to determine their molecular mass and energy relations. It seemed that as the laws relating to gases and liquids merge at what was called by Baron Cagniard de la Tour ‡ "l'état particulier," and by Dr. Andrews § the "critical point," an examination of matter up to the limit of the liquid state would be likely to yield us much information. The time we have to devote to scientific work being very limited, we found that it was quite impossible to make much advance by using the apparatus devised by Dr. Andrews, as the time required to change from one liquid to another was more than we had at our disposal. We therefore devised a new apparatus, which will be described in a more lengthy communication, but which, we may state, can be opened, the liquid changed, and again closed for a new experiment, in about one minute.

The question as to the state of matter immediately beyond the critical point being considered by Dr. Andrews to be at that time incapable of receiving an answer, we imagined that some insight might be gained into its condition by dissolving in the liquid some solid substance whose fusing point was much above the critical point of the liquid, and noticing whether, on the latter passing its critical point and assuming the gaseous condition, the solid was precipitated or remained in solution. We found that the solid was not deposited but remained in solution, or rather in diffusion, in the atmosphere of vapor, even when the temperature was raised 130° above the critical point, and the gas was considerably expanded.

When the side of a tube containing a strong gaseous solution of a solid is approached by a red hot iron, the part next the source of heat becomes coated with a crystalline deposit which slowly redissolves on allowing the local disturbance of temperature to disappear. Rarefaction seems to be the cause of this deposition, because if the temperature be raised equally and the volume retained at its original value, no deposition takes place. Those experiments have been done with such solvents as alcohol (ethyl and methyl), ether, carbon disulphide and tetra-chloride, paraffins, and olefines, and such solids as sulphur, chlorides, bromides, and iodides of the metals, and organic substances such as chlorophyl and the aniline dyes. Some solutions show curious reactions at the critical point. Thus ethyl alcohol, or ether, deposits ferric chloride from solution just below the critical point, but re-dissolves it in the gas, when it has been raised 8° or 10° above that temperature.

It appeared to us to be of some importance to examine the spectroscopic appearances of solutions of solids when their liquid menstrua were passing to the gaseous state, but as all the substances we have yet been able to obtain in the two states give banded spectra with nebulous edges, we are only able to state that the substances does not show any appreciable change at the critical point of its solvent. Such was the case with anhydrous chloride of cobalt in absolute alcohol. It was suggested to us by Prof. Stokes that the substance obtained by the decomposition of the green coloring matter of leaves by acids, and which yields a very fine absorption spectrum, might be useful for our purpose. We have prepared the substance according to the careful directions so kindly furnished us by Prof. Stokes, and find that it shows the phenomenon in a marked manner, whether dissolved in alcohol or ether. The compound is easily decomposed by heat under ordinary circumstances, and yet can be dissolved in gaseous menstrua, and raised to a temperature of 350° without suffering any decomposition, showing the same absorption spectrum at that elevated temperature as at 15°.

We considered that it would be most interesting to examine by this method a body such as sodium, which, besides being an element, yields in the gaseous state sharp absorption lines. An opportunity seemed to be afforded by the blue solution of sodium in liquefied ammonia, described by Gore,* but we found that, on raising the ammonia above its critical point, the sodium combined with some constituent of the gas, forming a white solid, and yielding a permanent gas, probably hydrogen.

There seems in some cases to be a slight shifting of the absorption bands toward the red, as the temperature rises, but we have as yet been able to make no accurate measurements.

When the solid is precipitated by suddenly reducing the pressure, it is crystalline, and may be brought down as a "snow" in the gas, or on the glass as a "frost," but it is always easily redissolved by the gas on increasing the pressure. These phenomena are seen to the best advantage by a solution of potassic iodide in absolute alcohol.

We have, then, the phenomenon of a solid with no measurable gaseous pressure, dissolving in a gas, and not being affected by the passage of its menstruum through the critical point to the liquid state, showing it to be a true case of gaseous solution of a solid.

Private Laboratory, Sword street, Glasgow.

* By J. B. Hannay, F.R.S.E., F.C.S., and James Hogarth. Read at the Royal Society, November 20.—*Nature.*

† "On the Microrheometer," "Phil. Trans. Roy. Soc.," 1879.

‡ *Ann. Chim.*, series 2me, xxi. p. 127; xvii. p. 410.

§ "Bakerian Lecture," "Phils. Trans. Roy. Soc.," 1869, p. 566.

* "Proc. Roy. Soc.," vol. xxi., p. 145.

THE SWEDISH NORTHEAST PASSAGE EXPEDITION.

DISPATCHES have been received by Mr. Oscar Dickson, of Gothenburg, from Prof. Nordenskjöld, giving an account of the wintering of the Vega, down to April 1; letters from Lieut Palander and other members of the Northeast Passage Expedition have also been published, some of them bringing down the narrative to a later date. From these, says *Nature*, we gather the following particulars:

The Vega was frozen in on September 28, 1878, in 67° 7′ N. lat. and 173½° long. W. from Greenwich, at the northernmost extremity of Behring Straits. The land in the neighborhood forms an extensive slightly rolling plain, bounded on the south by gently rising hills, which, farther into the interior, are said by the natives to reach a considerable height. The plain is occupied to a large extent by lagoons separated from the sea by low sandy beaches. When the Vega was frozen in the ground was covered with hoar frost and frozen, but still free of snow, so that it was possible to form some idea of the flora of the region. Close to the beach compact beds of *Elymus* were intermixed with carpets of *Halianthus peploides;* next, there stretched a poor level gravelly plain, only covered with a black lichen, *Gyrophora proboscidea*, and some few flowering plants, among which *Armeria sibirica* was the most common. South of this, again, was a tract occupied by lagoons and small lakes, whose shores were covered with luxuriant vegetation, consisting of grasses and *Carices*. On the neighboring high ground, where the soil, derived from weathered strata of gneiss and dolerite, is richer, the vegetation is marked by greater variety. Here were thickets of willows, extensive carpets of *Empetrum nigrum* and *Andromeda tetragona*, and large tufts of a species of *Artemisia*. Here were found also the frozen remains of the red whortleberry, the cloudberry, *Taraxacum officinale*, and other plants peculiar to the high north. In an excursion to the interior on October 8, Lieut. Nordquist observed that on the driest parts of the *tundra* the most common plants were *Aira alpina* and *Poa alpina;* on the lower places, *Glyceria, pedicularis*, and *Ledum palustre*. *Petasites frigida* and a species of *Salix* occurred everywhere, the latter growing in large compact masses covering spots several hundred square feet in extent, the bushes in some places being three to four feet high.

In the neighborhood of the Vega's winter quarters there were six small encampments, numbering from three to twenty-five tents each, inhabited by Tchuktches to the number of about 200. With these natives there was much friendly intercourse. They were allowed free access to the deck from which, though covered with a multifarious variety of articles, they did not remove the smallest trifle. They were not, however, altogether to be depended on in the statements they made regarding the articles they offered for sale. Thus, on several occasions what were represented to be hares were found to be dead foxes skinned and with the head and feet cut off, and the natives expressed great astonishment at the instant discovery of the deception. When they had acquired a taste for European food, they bartered drift wood and the bones of the whale for ship biscuit, and the quantity distributed partly in this way, partly as gifts, was so considerable as to contribute in no small degree to mitigate the famine that threatened to break out among the natives in midwinter. None of them were Christian, nor could any of them speak any European language, except one or two who could say a couple of words in English or a word of salutation in Russian. Lieut. Nordquist studied their language with such zeal and success, that in a fortnight he could make himself pretty well understood. He has collected materials for a comprehensive vocabulary.

When the Vega was frozen in, the sea next the coast was covered with newly formed ice, too thin to carry a foot passenger, but thick enough to prevent a boat from making any way. On October 8 the Tchuktches walked on board over the ice. Up to the 10th there were weak places between the vessel and the land, and a blue sky in the east still indicated open water in that direction. On the 13th it was ascertained that a belt of drift ice-fields, compactly frozen together, at least thirty kilometers in breadth, lay between the Vega and the open sea. The thickness of the newly formed ice was measured by Lieut. Bruzewitz, with the following results:

THE THICKNESS OF THE ICE

On December 1	56	centimeters.
" January 1	93	"
" February 1	108	"
" February 15	120	"
" March 1	128	"
" April 1	127	"
" May 1	154	"
" June 1	154	"
" July 1	103	"

For a distance of about six kilometers from the shore the ice lay all winter nearly undisturbed, but farther out it was in continual motion. So-called polynia, or open places, says Nordenskjöld, probably occur here all the year round, and in favorable weather accordingly we could see almost constantly a blue water-sky from true northwest to east. A southerly wind in a few days brought the open water within a few hours' walk of the vessel. It then swarmed with seals, which indicates that it was in connection with a sea always open. The neighborhood of such an open sea probably accounts for the fact that in the fields of drift ice that surrounded the vessel there was not a seal hole to be seen. On January 1 Lieut. Bove reached open water by a four hours' walk. From the fact that from a hummock five meters high he could see no boundary to the open water toward the northeast and north, and from the extent of the water-sky in that direction, he concluded that the breadth of the open water was at least thirty-five kilometers. The depth at the edge of the ice was twelve fathoms, the temperature —2° C. The water ran at a considerable speed right from the coast, (from south-southeast), apparently a tidal current. The open water swarmed with seals. No polar bear, no walrus, and no birds were seen.

During the long-continued severe cold in the month of January, in the course of which the temperature several times fell below the freezing point of mercury, the sea appears to have frozen completely for a great distance from the coast, but by February 7 mild weather again commenced, with variable and southerly winds. The same day a faint water-sky was seen at the horizon. Some kilometers to the east the beach was free of ice, and from the heights on land the seamen observed a high sea in the blue streak of water which bounded the horizon. The open water thus appears to have been very extensive. The statement of the natives that it extended to Behring Straits was, perhaps, correct.

The temperature during the wintering was as follows:

	Minimum. °	Maximum. °	Mean. ° C.
October	—20·8	+0·8	— 5·21
November	—27·2	—6·3	—16·59
December	—37·1	+1·2	—22·81
January	—45·5	—4·1	—25·05
February	—43·8	+0·2	—25·08
March	—39·8	—4·2	—21·65
April	—38·0	—4·6	—18·93
May	—26·8	+1·8	— 6·97
June	—14·3	+6·8	— 0·60

On two occasions the barometer was uncommonly high, viz.:

December 22, 6 A.M., 783·0 (0°) mm.
February 17, 6 A.M., 788·1 (0°) mm.

The lowest atmospheric pressure observed before April 1 was on

December 31, 1878, 2 A.M., 728·8 (0°) mm.

The weather during the winter was exceedingly stormy, and the direction of the wind near the surface of the earth was almost constantly between northwest and north-northwest. But in a stratum of air at no great height there prevailed, to judge from the motion of the clouds, a similar uninterrupted current from the southeast, which, when it occasionally sank to the surface of the earth brought with it heat and comparatively dry air. This is explained by Behring Straits forming a gate bounded by high hills between the warm atmospheric area of the Pacific and the cold area of the Arctic Ocean. The winds must here arrange themselves approximately according to the same laws as the draught in the door opening between a warm and a cold room. The cold stream of air must go below, and the warm above. The mountain heights which the natives say are to be found in the interior of the Tchuktch Peninsula, besides contribute to the heat and dryness of the southerly and southeasterly winds. For they give to the winds which pass over their summits the properties of the "föhn." The coldest winds have come from southwest to west, that is, from the Siberian Plain. On the existence of two currents of air which, at a certain height above the surface, contend with one another for the mastery, depends again the speed with which the sky in the neighborhood of Behring Straits suddenly becomes cloudy and again completely clear.

Nordenskjöld remarks that the fall of snow was not particularly great, but as there was no mild weather of any continuance during the winter, so that the snow was never covered with any continuous crust, a considerable portion of the snow remained so loose that it was carried backward and forward by the least puff of wind. With a storm or strong breeze, the snow was carried to higher strata of the air, which was so filled with the fine particles that it was impossible to distinguish objects at a distance of a few yards. But even when the wind was light and the sky clear, there went on a constant snowstorm a few inches in height along the surface of the ground in the direction of the wind, and so principally from northwest to southeast, carrying an immense mass of water in a frozen state over the north coast of Siberia to more southerly regions, and playing a sufficiently important part in a climatic respect, among others as a carrier of cold to the most northerly forests, to deserve the attention of meteorologists.

THE WONDERS OF THE AURORA.

The most remarkable observations which the wintering of the Vega has yielded appear to relate to the aurora. Our voyage happened in one of the years, writes Nordenskjöld, of which it was known beforehand that it would be a minimum aurora year. Just this circumstance has, however, allowed me to study, in a specially suitable region, this natural phenomenon under uncommonly favorable circumstances. For here the luminous arches, which also in Scandinavia generally form the starting points of the ray auroras, have shown themselves undimmed by the more splendid forms of the aurora, and one could thus devote one's self to collect observations toward a clearing-up of the right nature of these arches undisturbed by accidental accompaniments. Referring for details to a paper he has sent home for publication in the "Transactions" of the Swedish Academy of Sciences, he goes on to say that the aurora, during the winter 1878–79 never appeared with the splendid bands or draperies of rays so common in Scandinavia, but always in the form of faint luminous arches, which remain unaltered in position hour after hour and day after day. They were *constantly* visible when the sky was not clouded nor their feeble light dimmed by the rays of the sun or the full moon. The conclusions Nordenskjöld draws from numerous measurements of the height, extent, and position of these arches are, that our globe, even during a minimum aurora year, is ornamented with a nearly constant corona or circle of light, single, double, or multiple, whose inner edge during the

winter of 1878–79, had a height above the surface of the earth of about 0·08 of the earth's radius, whose center, the "aurora pole," was situated on the radius of the earth which touches the surface about 81° N. lat. and 80° W. lat. (Greenwich), and which, with a diameter of 0·3 of the earth's radius, extended itself in a plane at right angles to the radius of the earth which touches the center of the circle. This circle of light stands in the same relation to the ray and drapery auroras of Scandinavia as the trade winds and monsoons in the south to the irregular winds and storms of the north. Its light is never distributed into rays, but resembles that which passes through obscured glass. When the aurora becomes stronger the extent of the circle of light is altered, double or multiple arches are visible, generally lying in the same plane with a common center, and rays are thrown out between the different bows. Arches are seldom seen lying irregularly to or crossing one another. The area within which the *common arch* is visible (on the supposition that it can no longer be distinguished when its altitude is only 4° above the horizon) is bounded by two circles drawn upon the earth's surface with the aurora pole as the center, by radii revolving round it at angles measured on the earth's circumference of 8° and 28°. It touches only to an inconsiderable extent lands inhabited by peoples of European origin (the northernmost part of Sweden, Norway, Finland, Iceland, and Danish Greenland), and even in the middle of this area there is a belt passing over the middle of Greenland, the south of Spitzbergen, and Franz Joseph's Land, where the *common bow* commonly forms only a faint "veil" of light in the zenith. This belt separates the region where the luminous arches are seen mostly on the southern from those where they are seen mostly on the northern horizon. In the area nearest the aurora pole only the smaller, in the middle of Scandinavia only the larger and less regularly formed coronas are visible. But in the last mentioned region, as in Southern British America, the aurora storms and the ray and drapery auroras become common. The region where the aurora occurs in its most developed state is to be sought for near the circle which, with the aurora pole as a center, is drawn on the surface of the earth with a radius at an angle measured at the earth's circumference of about 24°.

The tidal observations, when compared with other series made in the Arctic seas, give important indications regarding the distribution of land and sea in the Polar basin. The greatest range at the Vega's winter quarters was only eighteen centimeters, which shows that the sea north of Behring Straits forms a marine basin of limited extent, connected with the ocean only by sounds. The variations in the height of the water, produced by winds, were much greater. They amounted nearly to two meters. Still greater irregular changes in the position of land and sea appear to have occurred within the memory of man. For the Tchuktches were at one time afraid that the Swedes would cause inundation along the coast. This appears to show that the sudden changes in the position of the earth which are well known in the volcanic regions farther south had extended so far north. As most of the Tchuktch villages are situated close to the sea, one of the mighty waves which earthquakes give rise to would completely destroy an immense number of them.

The magnetical observations made during the wintering, in an observatory built of ice and snow, which, being necessarily on land, was at a very inconvenient distance from the vessel, consisted of (1) absolute determinations whenever opportunity offered; (2) observations of the changes in the strength and direction of the magnetic forces made along with necessary absolute determinations every hour between November 27 and April 1; (3) five minute observations on the 1st and 15th of every month from and including January 15.

With reference to the natural history of the region in which the Vega wintered, Prof. Nordenskjöld states that it is very poor in the higher plants and fungi, but lichens are abundant. The number of insects and other intervertebrate land animals was very small. Land and fresh water mollusca were completely wanting. Of coleoptera only twenty species were found, belonging principally to the families *Carabi* and *Staphylini*, with two *Curculiones* and *Chrysomelæ*, and the other orders appeared to be equally poor, with the exception, perhaps, of the *Diptera* and *Podurida*. On the other hand the sea-bottom, though covered with a stratum of water always about 2° C. below the freezing-point, swarmed with a large number and a great variety of the lower animal types, of which the dredging-boat almost daily made a rich collection in the channel, which opened early in summer in the neighborhood of the vessel. Prof. Nordenskjöld expected that the same avifauna would be found with little variation in all the Polar lands. Experience has, however, shown that this is by no means the case, the Tchuktch peninsula being quite an exception. Birds here occur in much fewer number, but in a much greater abundance of types than in Novaya Zemlya, Spitzbergen, and Greenland, and the bird-world in its entirety has thus quite a different stamp. The birds common on Greenland, Spitzbergen, Novaya Zemlya, and the coast of North-west Siberia, *Larus glaucus*, *eburneus*, and *tridactylus*, *Harelda glacialis*, *Somateria spectabilis*, *Plectrophanes nivalis*, *Phalaropus fulicarius*, and *Tringa maritima*, the common raven and several other species, are found here. But in addition to these the following uncommon birds are met with: The American eider, the common eider, *Somateria mollissima*, being absent; a grayish-brown goose with bushy yellowish-white feathers round the neck; a swan-like goose, white, with black wing-feathers, a species of *Fuligula* marked in white and green with a fine black-velvet head, the beautifully-marked, uncommon *Larus Rossi;* a little brown snipe with a bill widened spoon-like at the point; several beautiful singers, among them *Sylvia Eversmanni*, which for some days visited the coast in great flocks, probably on their way to breeding-places farther north, or waiting till the bushes in the interior should be free of snow. A portion of the purely Scandinavian species here exhibit some variations in color-marking and size.

The mammalia are also more numerous than in other places visited by the Swedish expeditions. According to Lieut. Nordquist the most common mammal is the hare. It differs from the common Scandinavian mountain hare by its greater size (its weight often rising to 14 lb.) and by the nasal bone not diminishing so rapidly in size. The mountain fox (*Vulpes lagopus*, L.) is very common. The common fox (*Vulpes vulgaris*, Gray) appears also to be common. A red fox, shot in October, differs considerably from the common, and approaches the mountain fox in several particulars. The fox's food during winter appears to consist of hares, ptarmigans, and lemmings. Of lemmings three species were met with, *Myodes obensis* (the most numerous), *M. torquatus*, and *Arvicola obscurus*. The Tchuktches state that a little mouse also occurs, which Nordquist supposes to be a *Sorex*. The two lemmings often showed themselves above the snow during winter, which was not the case with *Arvicola obscurus*. The wolf was seen only twice. The wild reindeer was also uncommon, traces of them having been seen only once. Traces of the land-bear were also seen, and the natives stated that they were not uncommon in summer. The marmot (*Arctomys*) occurs in abundance. An animal described by the natives as living by the banks of streams is supposed to be the common otter. Two weazel-skins were obtained from the natives. It is not certain whether the ermine occurs there. Only two marine mammals have been seen during the winter, the Polar bear and the ringed seal (*Phoca fœtida*). The latter is caught in great numbers, and along with fish and various vegetables forms the main food of the natives. Of land birds there winter in the region only three species, viz., *Strix nyctea*, *Corvus corax*, and *Lagopus subalpina*. The last-mentioned is the most common. On December 14 two large flocks of ptarmigan, one numbering about fifty, were seen about ten miles from the coast. The raven is common at the Tchuktch villages. Its first egg was obtained on May 31. The mountain owl was seen for the first time on March 11, but according to the natives, it is to be met with all winter. In open places on the sea there occur during winter, according to the natives, two swimmers, *Uria Brünnichi* and *Uria grylle*. Besides these there possibly winter on the sea a species of *Mergulus* and one of *Fuligula*, a specimen of the former having been obtained on November 3, and of the latter on March 9.

During the wintering of the Vega large quantities of the bones of the whale were found on the beach. These at first were supposed to be the remains of whales that had been killed by the natives or by American whalers. On examination it was found that they must be sub-fossil. This was confirmed by the natives, who stated that no whale had driven on land in the memory of man. The remains were found to belong to four or five different species, of which *Balena mysticetus*, or a nearly allied type, was the most common.

Prof. Nordenskjöld investigated the formation of the strata of frozen earth several hundred feet thick which occur in Siberia as in Polar America. Along the coast of Siberia there is a stratum of water resting on the bottom of the sea which is several degrees below the freezing-point, so that a flask of the comparatively fresh surface water, when sunk into this stratum, begins to freeze. Stuxberg observed that the trawl-net often froze fast to the bottom. This was accounted for by the freezing of the fresh water which the net carried down with it from the surface. Nordenskjöld thinks that the mud carried down by the rivers into the sea as it sinks to the bottom carries with it fresh water adhering to the minute particles, and that this fresh water, like that carried down by the net, freezes at the bottom, forming thus a frozen stratum, which increases year by year until it reaches an enormous thickness. He is of opinion that a portion of the earthy layers of Siberia was formed in this way, although, he adds, he by no means considers this the only way in which such formations arose.

Along the whole coast, from the White Sea to Behring Straits, no glacier was seen. During autumn the Siberian coast is nearly free of ice and snow. There are no mountains covered all the year round with snow, although some of them rise to a height of more than 2,000 feet. With one exception there were no rocks along the coast precipitous enough to be suitable breeding-places for sea-fowl, but a large number of these birds were seen during spring flying farther to the north.

During the voyage of the Vega from her winter quarters through Behring Straits and farther south, Nordenskjöld searched for a tribe called Onkilon, said to be allied to the Eskimo, but without success. He found only reindeer-owning Tchuktches, and supposes that the name Onkilon, given by Wrangel to the old tribe inhabiting the coast and driven out by the Tchuktches, is probably related to the name Ankali, given by the reindeer-owning Tchuktches to the coast Tchuktches. Nordenskjöld states that English authors who refer Eskimo and Tchuktches to the same origin are mistaken. It was found that the inhabitants on the American side are pure Eskimo, with whom it was possible to carry on barter by means of the list of Eskimo words published in "Arctic Geography and Ethnology," London, 1875; but that the language spoken by the Tchuktches, of which Lieut. Nordquist collected about 1,000 words, is quite different, and probably allied to that of the Iranian races. On the other hand there is a complete correspondence between the household furniture of the Tchuktches and the Eskimo. It may be safely affirmed, he says, that these two neighboring races have a greater number of identical articles in their tents than of common words in their languages.

The hills at Cape York on the American side were found to consist of crystalline schists without organic remains. Among the natives, who were Eskimo, there was a Tchuktch woman who said that Tchuktch tribes were settled on the American side between Point Barrow and Cape Prince of Wales. The Eskimo used, along with breechloaders, revolvers, and axes obtained from the Americans, bows and arrows, bone boat-hooks and various stone implements. They were friendly and agreeable, and less given to brandy than the Tchuktches. There did not appear to be any chief among them. Complete equality prevailed, and the standing of the women did not appear to be inferior to that of the other sex. Among the stone implements were found arrow-heads and other articles of a species of nephrite so closely resembling the well-known nephrite from High Asia, that these implements were supposed to have actually come from that region.

A warm current, as in Europe, was found to flow along the north-western coast, and to create there a far milder climate than that which prevails on the Asiatic side. The limit of trees therefore lies a good way to the north of Behring Straits, while the whole of the Tchuktch Peninsula appears to be devoid of trees. This is the case also with the land along the coast at Port Clarence, but a short distance inland there were bushes two feet high. Vegetation was generally luxuriant, and a great number of species were identical with, or nearly allied to, those of the Scandinavian north, among others the *Linnea*. Notwithstanding the luxuriance of the vegetation, the land invertebrates were much poorer in species than in the north of Norway. Thus only from ten to twenty kinds of beetles could be found, principally *Harpali* and *Staphylini*, and of land and fresh-water mollusca only seven or eight species. The avifauna was also rather scanty, and the dredgings in the harbor at Port Clarence, on account of the unfavorable nature of the bottom, yielded only a small number of animal and vegetable species.

The Vega, crossing to the Asiatic side, anchored in Konyam Bay on July 28, 1879. On the north shore of this Bay Dr. Kjellman added seventy species of flowering plants to the collection he had previously made. Here, too, were found the first land mollusca on the Tchuktch Peninsula. Nordenskjöld considers it probable that on the southern part of this peninsula there was in former times a little inland ice. On July 31 the Vega was anchored at St. Lawrence Island. Drift ice was seen for the last time. The quantity of ice carried by the Polar current through Behring Straits is very inconsiderable, and it has evidently been for the most part formed along the coast. Not a single iceberg was visible, the whole of the ice seen being level and rotten "year's ice." St. Lawrence Island is inhabited by Eskimo, who having frequent intercourse with the Tchuktches, have adopted some of their words. The prevailing rock is granite, weathering readily, and thus giving origin to a very fruitful soil. Vegetation was exceedingly luxuriant, and rich collections of land and marine animals, lichens, and algæ were made.

The Vega next anchored off Behring Island on August 14. This island belongs to Russia, but the American Alaska Company has acquired the right of hunting, and maintains a station where skins, principally those of the *Otaria ursina*, are purchased. Between 50,000 and 100,000 of these animals are killed yearly on this and the neighboring Copper Island. They yield the brown "sealskin," so much in fashion in recent years. Behring Island is supposed to have been visited first by Behring, who, after being shipwrecked, died there in 1741, survived, however, by many of his companions, among others, by the talented naturalist Steller, who described the natural history of the island in a masterpiece that has seldom been surpassed. Since Steller's time great changes have taken place. The *Canis lagopus* then occurred in incredible numbers. Now they are so uncommon that not one was seen, and those that remain are not dark blue, but white, the skins being of little value. On the neighboring Copper Island dark blue foxes are still found in considerable abundance. In 1741–42 Steller and his companions killed here about 700 sea otters. This animal, famous for its precious fur, is now quite extinct on Behring Island. Of the sea lion (*Otaria stelleri*), formerly abundant, only single specimens are to be found along with the sea bear (*Otaria ursina*) on the rocky shores of the island, and the great sea cow, the most remarkable of all the animals formerly belonging to Behring Island, is now completely extinct. Stellar's sea cow (*Rhytina stelleri*) was of a brownish color, covered with hair which grew on a hide resembling the bark on an old oak. Its length, according to Steller, was sometimes as much as thirty-five feet and its weight nearly 50,000 lb. The female yielded abundance of milk, which, along with the flesh, resembled, and were even, according to Steller, superior to those of the cow. The sea cow fed on the abundant algæ along the coast in great herds. According to Middendorf, the last sea cow was killed in 1768. Nordenskjöld, however, found a "creole" of mixed Russian and Aleutian blood, whose father had come to the island in 1777, and remembered the killing of sea cows while they fed on seaweed at low water for the first two or three years (1779 or 1780) after his arrival. Nordenskjöld also found two men who had seen, about twenty-five years ago, a large animal corresponding to Steller's sea cow. He also obtained two complete skulls of the animal and a quantity of bones sufficient to fill twenty-one large boxes and barrels. The sea bear (*Otaria ursina*) is the only large animal that exists on the island in about as large numbers as in Steller's time. It is "preserved" by the Alaska Company, only a limited number being killed yearly.

The vegetation on Behring Island was found to be exceedingly luxuriant, and the sea in its neighborhood one of the richest in algæ in the world. Forests of algæ, sixty to a hundred feet high, grew in favorable situations, rendering dredging exceedingly difficult. Some of the algæ are used by the natives as food.

The small streams swarmed with a number of different kinds of fish, among them a species of *Coregonus*, a little *Salmo fario*, a middle-sized salmon with nearly white flesh and a purple skin, and another of the same length, but very thick, and with a hump on its back. Other species of salmon with deep red flesh are found in the larger rivers. Leaving Behring Island on August 19, the Vega reached Yokohama on September 2, 1879, in good order and with every man on board in excellent health. There had not been a trace of scurvy during the whole voyage.

CERRO DE PASCO, PERU.

CERRO DE PASCO is situated on the Andes range of mountains in South America at an elevation of 14,500 ft. above the sea level, and about 150 miles west of Lima. The town contains some 20,000 inhabitants, all more or less connected with the silver mines of the neighborhood. Callao is the shipping port for Lima, Cerro de Pasco, and the adjacent district.

Up to a recent date a bridle road or mule track was the only route between Lima and Cerro de Pasco whereby goods or machinery could be transported, and this limited the size and weight of every package to a single mule, the maximum weight of which could not exceed 300 lb.; it is preferred by the mule drivers to take two articles of 150 lb. each, which may be slung on either side the mule, to one weighing 275 lb., because the mule carries his double load more easily, and the difficulty of loading and unloading is vastly diminished when light packages are carried, and when it is borne in mind that several days were occupied by the journey this becomes an important consideration.

The nature of the country makes the transport of all materials extremely difficult; at one point of the route an elevation of 16,000 ft. has to be surmounted, and at several places the track would admit of only one mule passing at a time.

The above-named route is now nearly out of date, the Oroyo Railway, which has been constructed from Lima to within 90 miles of Cerro de Pasco, takes the bulk of the trade as far as it goes, and the last 90 miles is still done by mules, which limits the usefulness of the railway, and is very little help towards diminishing the enormous cost of transport.

The cost of mule carriage from Callao to Cerro de Pasco was equal to 3*l.* 16*s.* per mule load, or 27*l.* per ton, and the cost is now very little less by railway and mule. The new railway has been constructed in a very ingenious manner, and gullies are crossed and rock pierced in a manner only seen in precipitous mountain districts. The gradient is surmounted by means of zigzags.

The climate is remarkably healthy; extremes of temperature are unknown, but constant and rapid changes take place, snow and sunshine alternating; the former very rarely lies upon the ground more than a few hours at a time; high winds are seldom heard, the normal condition of the atmosphere being extremely tranquil. Thunderstorms of a violent character, but of short duration, are frequent,

and deaths by lightning are comparatively numerous. Earthquakes, although destructive and violent on the coast, are as rare as they are in England, the enormous weight of the mountains seeming to act as the weight of a safety valve on the volcanic region. The height of the barometer at Cerro de Pasco stands with little variation at 17 30 in. to 18 in., which gives an atmospheric pressure of 8·5 lb. per square inch as against 14·7 lb. at the sea level. Water commences to boil at a temperature of 186 deg. Fahr., below the boiling point at the coast.

Cerro de Pasco lies about the center of a rich mineral district which bears every indication of being the crater of an extinct volcano; it contains copper, lead, tin, and silver ores in vast abundance, the latter metal being that chiefly worked; the other minerals named are practically of little value owing to the difficulties and expense of land carriage. Coal in great abundance, and of almost all descriptions, from bog coal and cannel to semi-bituminous or anthracite, is found a few miles from Pasco, and is carried on the backs of llamas driven in droves like sheep; each llama carries 100 lb. The cost of coal delivered at Pasco is about 2l. 10s. per ton.

The two principal argentiferous veins of the district cross one another at the town of Pasco at an angle of about 70 deg.; the first or leading vein runs from north to south to an ascertained length of about 3,500 yards by 130 yards wide, the other runs in a west-north-westerly direction; the length has been traced for 2,100 yards, and breadth 126 yards; from these main arteries smaller veins branch off in all directions.

The silver mines so called are mere surface workings, more like enlarged rabbit warrens than anything else; some are entered by surface holes, often covered by the miner's hut, and from holes excavated on the premises of the mine-owner. These holes frequently "cave in" and bury the unfortunate Cholos. The mining, such as it is, is done by six to eight months, according to quality, and when worn down to about 5 ft. diameter, they are taken out and converted into bottom stones or saucers. The cost of these stones is a very heavy item in the expense of the hacienda or establishment, the value in place being nearly 80l. each.

The ore is ground in the saucers by the edge runners till it is sufficiently fine to flow away with the water into receivers over the edges of the saucers: a constant supply of water is given while the grinding process is going on. After the ore is ground as described it is conveyed to circular yards called "cirtos," each about 36 ft. in diameter, paved with stone, and inclosed by a dwarf wall about 3 ft. to 3·6 ft. high. The ground ore is spread over the entire floor of the circos in the shape of thick mud to a depth of some inches, the whole is then closed with salt, lime, quicksilver, copperas, and water. Eight horses or mules are brought into each circo, and driven round and round to mix the whole up together; the driver stands on a stone in the center. This process is continued during thirty or forty days, the stuff is then washed in a running stream between the circos, in which pots are placed at intervals to catch the metal, and when collected from the pots it is filtered through large cone-shaped bags suspended from the roof of the buildings; the bulk of the mercury is by this means allowed to drain off into vessels placed to receive it, and is recovered for future use; a large percentage is of course lost. The residuum is turned out on a skin-covered table, and moulded into brick-shaped cakes, which are piled upon the floor in the form of a cylinder, and then covered by a wrought iron bell open at the bottom; a charcoal or coke fire is then built round the bell, and the quicksilver remaining in the amalgam is driven out by the heat, and falls into receptacles placed beneath to receive it. The silver which remains has a porous and beautifully frosted appearance, and is taken to the smelting house, assayed, and run into ingots or bars, when it is ready for the market. The machinery employed at the mines is chiefly for grinding the ore, and all the haciendas except the Hacienda Esperanza use water power. The latter is chiefly owned and managed by English, and is the only establishment where steam power is employed. The above sketch of the several processes of reducing the ore to the silver of commerce will make it understood that the grinding process is of considerable importance.

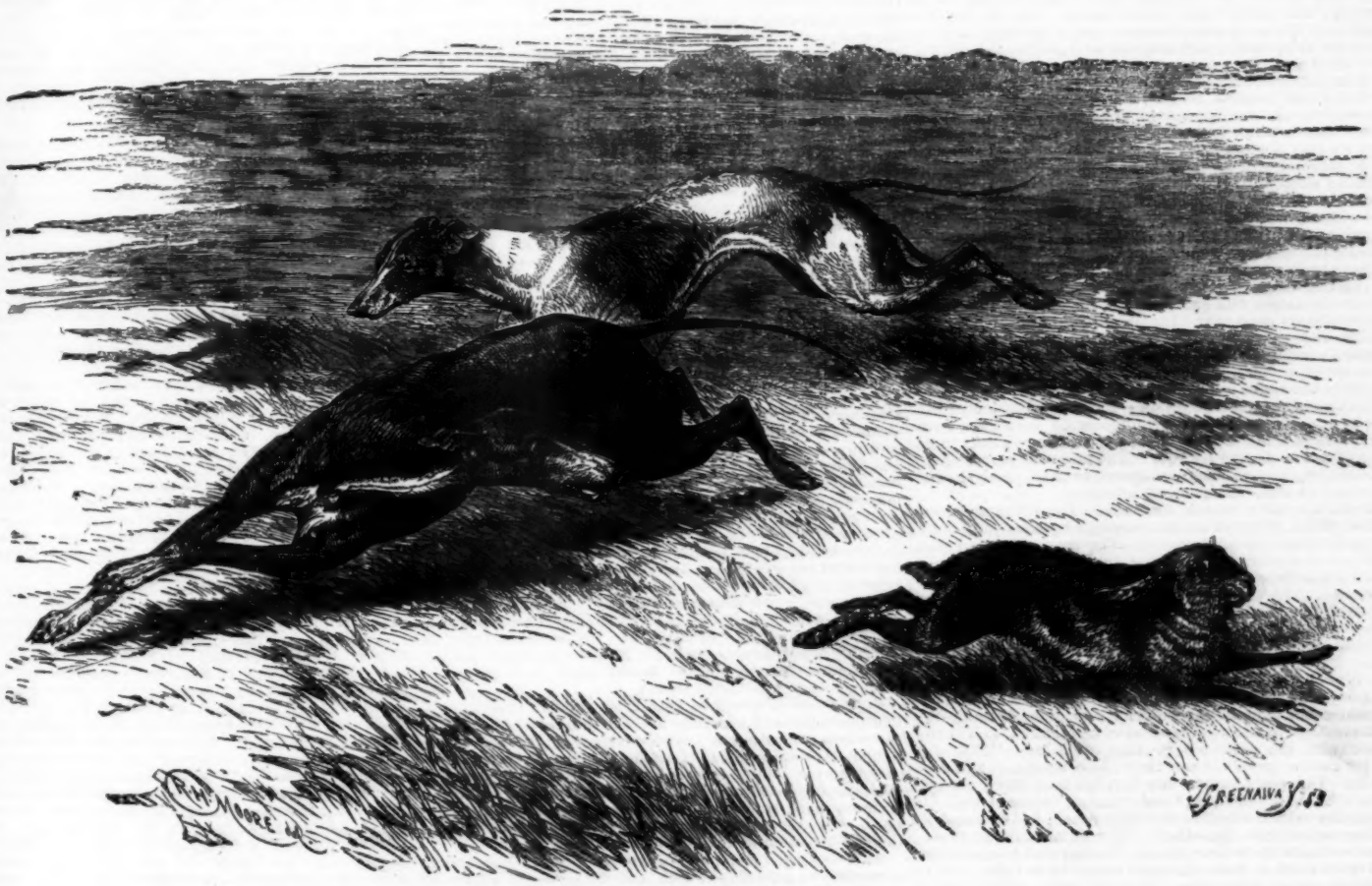
At a depth of 150 ft. to 200 ft. water is met with, and the deepest workings have yielded the best ores. Many attempts have been made to drain the mines by pumping machinery, and much was done with that object, shafts sunk, and machinery erected; but difficulties of transport, the apathy of the Peruvians themselves, and jealousy of foreigners, have hitherto made all these attempts abortive. Ores of great richness are known to exist below the water level. It is stated that some years ago an iron bucket was fished up from the bottom of a shaft coated with silver like thick electroplate.

The processes for reducing the ore, it will be remarked, are of a rude and primitive description. The difficulty and expense of introducing anything new or uncommon into this region is extremely great, chiefly owing to the wonderful stupidity and ignorance of the native Indians, who are capable only of doing the meanest labor; they are, in fact, little better than beasts of burden. Europeans have to be sent out expressly to erect machinery, and the cost of passage out and home, the high wages paid them, 12s. per day to fitters, smiths, and masons, and the difficulty of controlling these men, where there is no competition, offers very serious obstacles in the way of all improvement. Various attempts to drain the district have been made, and ended in failure; the last and best scheme, that of Mr. Meiggs, was brought to an abrupt stop by the death of that gentleman; this scheme was an adit driven at a sufficiently low level to drain all the mines. It will be resumed some day, and then the vast wealth of the district will be developed. Salt mines are worked at a distance of a few leagues in the same primitive fashion as the silver mines.

The collieries are wonders of abundance. One colliery is a mass of coal of unknown depth and thickness, worked by free level; all the coal is brought out on the backs of the miners, except at the colliery of the Hacienda Esperanza, where a light hanging railway is in use, and this has only lately been introduced. The fact of the railway not being completed from Lima is seriously detrimental to the welfare of the place. In the hands of Englishmen or Americans this wonderful region would have produced untold wealth, but in the hands of Peruvians no progress can be hoped for or expected. Nature's gifts are most abundant. Mineral wealth of all kinds is there ready to hand; all that is wanted is rapid and cheap transport to the coast, but while the vain Peruvians are electing or deposing presidents, fomenting revolutions, and making war on neighboring states, as vain and insignificant as themselves, the development of the mineral resources of their country is neglected, and the energy and capital of foreigners who attempt it are wasted and made abortive by the crass ignorance of a proud and indolent race of people by whom it is the misfortune of the country to be governed.—*Engineering.*

COURSING—THE FIRST TURN.

DURING the coursing season we very frequently read a sentence to this effect in the reports of the various meetings: "Mr. A's decisions, as usual, gave complete satisfaction, and B was in great form with the slips." The importance of securing an able judge and an experienced slipper cannot possibly be over-estimated, for we have no hesitation in saying that Wilkinson's task, when a pair of awkward pup



COURSING—THE FIRST TURN.

the natives, a diminutive race of Indians; the silver ore (which is in appearance a kind of brown gravel) is brought to the surface by these men on their backs in leather bags or skins. Europeans or natives of the low countries are incapable of prolonged exertion in the rarefied atmosphere of the Cerro, a difficulty of breathing effectually prevents new-comers from active exertion, such as they have been accustomed to in localities of moderate elevation, and this will be more readily understood when it is borne in mind that Cerro de Pasco is within 500 ft. of the summit of Mont Blanc. The ore contains from 30 to 60, and sometimes more, per cent. of silver, and when brought to the surface is deposited in a heap near the hacienda, preparatory to its undergoing the first process, which is grinding by immense edge runners of granite, 8 ft. to 10 ft. or 12 ft. in diameter, and 18 in. to 20 in. wide. These stones are quarried at about 40 or 50 miles from Cerro de Pasco, and are transported over a rough country. A square hole is made in the center of the stone; and a long beam wedged in, projecting about 3 ft. through the stone, at the other end of the beam a small rough kind of wheel is put on revolving on the beam, this also has about 3 ft. of the beam projecting through it, and a bridle chain is looped over the two ends; then a team of 24 to 26 oxen and bulls are yoked on, and as many as 48 oxen may be seen occasionally yoked to one stone. In this way the stone is dragged over a wonderfully rough country; and the descent of steep places is no less singular. The stone is brought carefully to the edge of the declivity, the oxen yoked the opposite way, then a lever tilts it over the edge, and the bulls ease it down backwards; sometimes the stone proves too heavy, and overpowers the bulls, dragging the whole team down the hill in a helpless mass. The treatment the poor animals get at the hands of the natives is abominable, but the drivers manage them wonderfully, and seem to be able to get the stone over almost impossible obstacles. Each of these stones will last from

pies are given into his charge, is quite as difficult as that undertaken by Mr. McGeorge when he has to get a field of two-year-olds off upon equal terms; while Judge Clark's post is a sinecure compared with that held by Mr. Hedley. In Manchester, Sheffield, and other northern towns, where the somewhat bastard sport of rabbit coursing is practiced, a very rough-and-ready style of judging is adopted. The "kill" counts one, and that is the only point that is scored, so that it is possible for one dog to do the whole of the work, while the other, by a piece of luck, secures the verdict. With greyhounds, however, matters are very differently arranged. The kill certainly counts one point; but far more value is attached to "speed to the hare," first turn, etc.; and as the judge often has to sum up these points while riding at full speed to keep in a good position with the dogs, it is wonderful how rarely his decisions are called in question. Occasionally the best and most experienced judge will make a mistake, but we never remember to have heard the slightest insinuation of unfair dealing. Many years ago an offer of £500 was made to the judge at one of our most important meetings if he would give the final course of a great stake to a certain dog. He entertained the proposal and dismissed it—with the stewards.

The work of the slipper is of little less importance than that of the judge. It may seem a very simple matter to the uninitiated to pull a spring which sets free two greyhounds; but a little practical experience would soon show the fallacy of this idea. Many dogs are very troublesome in the slips, and, instead of straining forward with a steady even pull, one will be plunging about in all directions, while the other perhaps has become unsighted. Then the slipper has to exercise a considerable amount of discretion with regard to the course the hare is taking, and, if one dog is likely to be much favored, he must wait for a fresh hare. In our illustration, however, all the preliminary difficulties have been satisfactorily overcome. The dogs have got away upon

even terms, and, after a grand race to the hare, in which the speed shown has been very equal, one has made a desperate effort, drawn out a little, and sent "puss" round, thus gaining the coveted "first turn." If the hare is a good one, the course is likely to extend for another mile, and, from this point, stamina and cleverness will be served rather than speed, and the scorer of the first point may not be found to have held his own, when the little flag goes up, proclaiming a victory for white collar or red.—*Illustrated London News.*

THE PEARL FISHERIES OF THE PERSIAN GULF.

CAPT. E. L. DURAND, of the British Protectorate of the Persian Gulf, reports that the pearl fisheries of the Gulf are worked by the maritime tribes of Fars and Oman, and afford sustenance to about 35,000 families. The British protectorate, which extends over the Gulf, insures the peaceful prosecution of this industry; piracy is abolished, and intertribal difficulties are referred to the Resident, whose decision is final. Two taxes, called "Nob" and "Traz," are, however, levied by the maritime sheikhs; and though the amount realized thereby is uncertain, there is good ground for supposing that it is considerable.

The trade is really in the hands of the Indian bunnias—traders who are found flourishing far beyond the confines of British India, but generally where the British flag affords them security in their dealings. The bunnia makes pecuniary advances to the nakhoda or headman of the boat by supplying him with every necessary of clothes, food and tobacco required for the trip; and these supplies go down in the bunnia's ledger at his own valuation. On his return the headman hands over his packet of pearls to be valued in the gross and the bunnia takes them at a discount of 20 per cent., often paying for as much of the balance as he can in goods and stores, over which he makes from 20 to 35 per cent. profit. Altogether, the arrangements are favorable for the accumulation of much wealth by these "canny" traders. The crew consists of the nakhoda, or master, who often owns the boat himself; the sebs or haulers, who are usually Bedouins, but sometimes Persians, and whose duty it is to work the ship, handle oars and sail, and pull up the divers; and the "ghoas," or divers, who are generally Sedees, or poor Arabs, or Sedee slaves. The ghoas will go on diving all day, if the weather be fair, merely taking short rests in the water to recover breath and strength. As a rule, they do not remain below longer than 50 to 70 seconds. These men are very abstemious. They eat half a pound of dates in the morning and drink three or four cups of coffee after morning prayers, and they begin fishing at sunrise. About two o'clock they all come out of the water for coffee, prayers, and a siesta, which lasts for about an hour, when they go to work again till sundown. At night they eat a hearty meal of roast fish and dates, and strike work for the day. From eight to twelve fathoms is the usual depth at which work is carried on, though a good diver has been known to go down as deep as sixteen fathoms—a depth, however, which is insupportable to most men. The diver's equipment is a weight for the feet, a pair of horn pincers for his nostrils, a rope round his waist, and leather tips to his fingers to save them from abrasion. When devil-fish are more than usually prevalent in the vicinity the diver puts on a long white shirt as protection against their burning embraces. Accidents from sharks or dogfish are said to be unknown. As a rule, however numerous the shells may be, a man cannot gather more than fifteen or sixteen per dive. The incessant plunging entails sundry diseases, such as madness, cramps, paralysis, and softening of skin, besides minor ailments.

There are three fishing seasons—in the spring, summer, and winter, during which last-mentioned period only wading in the shallows is attempted. The pearl oyster is found in all the waters up the Gulf, but the best beds lie on the Arab side between the 24th and 27th degrees of North latitude and 50th and 55th degrees of East longitude, between Shiltaye and Sir-beni Yas Island, at a distance of from one to ninety miles from the shore. But the deep-sea banks are not much fished till the "shemal," or nor'-westers of June, which are peculiarly sudden, severe, and of certain yearly occurrence) have spent their force.

It has been asserted that the yield of these fisheries is decreasing, but Captain Durand is inclined to discredit the statement. The divers are too wise, he remarks, to kill the goose with the golden eggs; they often say, "That will do for another year," when they come upon a small lot of shells. The pearl oysters are divided into three classes, called "zinni," "sudaifee," and "mahar," respectively. Of these the mahar contains the best pearls, and is found in deeper water than the others. The sudaifee does not produce such a white or heavy pearl, but one that is said to improve by keeping, while the zinni is said to be lighter and to be liable to change in color. There are three colors found—namely, white, red, and blue. Every year many small pearls turn up, ranging in value from two rupees upward; and in these smaller pearls a considerable trade is done, one order (cited by way of example) being for small pearls to the value of £4 7 for sewing on the horse trappings of a Persian noble. The usual mode of disposal is by packets, but should the merchant pick and choose he must be content to pay a fancy price. The value of the annual export of pearls from the Gulf is difficult to determine; but the British Resident, Colonel Ross, puts it at about $3,000,000, and Captain Durand at nearly $4,000,000.

ON THE HYGIENIC AND THERAPEUTIC INFLUENCE OF HABITS AND CHARACTER IN THE MEDICAL PROFESSION.*

By EDWARD T. TIBBITS, M.D. Lond., Physician to the Bradford Infirmary and to the Bradford Fever Hospital.

THE subject upon which I propose to make a few observations has most probably been reviewed again and again in the minds of many medical men. It has not, however, as far as I am aware, received that amount of attention which it appears to me to deserve.

I shall take for granted at the outset that anything which on the one hand tends to the prevention, diminution, or cure of disease, or on the other favors its development or retards restoration to health, comes legitimately within the domain of medicine, and therefore demands the earnest consideration of those engaged in the practice of it.

It is self-evident that, in common with every member of the human race, a medical man, apart from his profession, exerts some kind of influence over those with whom he comes in contact. And the amount of influence one individual is capable of exercising over another varies infinitely according to the particular combination of habits and types of character. The courageous, humane, and high-principled general imbues his soldiers with a spirit of fortitude, humanity, and uprightness; and as certainly do timidity, cruelty, and immorality in the leader of an army tend to the inefficiency and demoralization of his troops. Does not history teach us, and have we not numerous instances constantly occurring among us of the power one man possesses, either in word or deed, or both, of inducing others to act as he wishes and advises, although their views are not precisely in accordance with his own? Without further preface, I will at once proceed to consider the special influence of medical men, which may be conveniently regarded as of a twofold nature—social and professional.

With regard to its *social* aspect, it must be borne in mind that medical men are the recognized custodians of the public health. Speaking generally, it is admitted that they know what will produce disease and what will prevent it. But further, independently of his professional knowledge, there is no one more capable of exercising so much influence on the lives of others as a medical man. He is entreated to enter where no one else would be tolerated for a moment. In many instances he is made the confidant of the family, and he sees more of the petty crosses and annoyances of his fellow-creatures, their causes and results, than any other member of the community.

Important as this social aspect of the question appears to be, it is almost insignificant when compared with what I have termed provisionally its *professional* aspect, and which is embodied in the following proposition: That although every medical man generally undergoes similar training, and for the most part acknowledges the truth of certain facts concerning the preservation of health and cure of disease, his actual mode of practice is moulded and regulated to a considerable extent by his habits and character.

It requires but little argument to prove that every man is distinguished from his fellows by some innate peculiarities of mind or body or both. And these may justly be regarded as the germs from which the future character is developed. As it is possible for the germination of the ovule, the nutrition and growth of the young plant, to take place under conditions which may materially alter the original properties of the seed, so, by judicious management during infancy and childhood, it is possible to modify the congenital tendencies of character. But once adolescence is attained, in by far the majority of cases a ruling principle has become indelibly stamped upon the constitution, and habits initiated in childhood, persevered in through youth to manhood, are almost inseparably connected with every thought, word, and deed.

Whatever be the rank, employment, or profession, we shall find that the manner of transacting business, or following an occupation, whatever it be, is directed by that ruling principle which we call character, and modified to a greater or less extent by those habitual actions, many of which become, after frequent repetition, almost involuntary. If this be so, is it not worth while inquiring how far it can possibly affect medical men in the practice of their profession.

Firstly, perhaps, it will not be out of place briefly to direct attention to what may be reasonably designated as "medical fashions." Apart from hyper-depletion and hyper-stimulation, each of which has had its day, do we not observe fashion in other methods of treatment? One drug after another appears to fascinate the professional mind, and although a particular remedy may be extremely valuable in certain cases, the tendency is to make a much too general and indiscriminate use of it. It is not at all improbable that the robust, and those who indulged immoderately in luxuries, profited by the method of depletion practiced a century ago. But the *habit* of bleeding, etc., was so general (just as the *habit* of condemning bleeding is so general in the present day) that possibly the innocent sometimes suffered with the guilty, and the delicate and abstemious were mulcted in a fine of a few pounds of blood, and, as a natural consequence, a few weeks, months, or years of earthly existence. And so, indeed, it is with certain powerful remedies in the present day. Although of undoubted efficacy in carefully-selected cases, their too frequent or incautious administration has, within the knowledge of most of us, led to dangerous, if not fatal, results.

But, secondly, it will be found, on careful examination, that the habits and character of each individual member of the medical profession have a tendency to develop a particular style of practice. Considering the numerous phases of character which must of necessity exist among the medical portion of the community, it will not be possible to do more than glance briefly at some of the most striking ones. For the sake of example, let the following be the direct delineation of an imaginary character:

A. B——, aged forty, in country practice, is a fine, active, powerful, well-developed man, and the father of numerous healthy children; has always had good health, lived without stint, but perfectly temperate withal, accustomed to plenty of exercise, a bold horseman, and fond of field sports generally. He is an honest, good-tempered, jovial fellow, but somewhat deficient in feeling. His profession is quite secondary to his love of country life, hence it is extremely probable that he never allows himself to be puzzled over a case, and one of an unusual character would not induce him to make any vigorous intellectual attempts to unravel it. Now, this man's character is a type of activity; he is bold and courageous, and whatever he does is done quickly and with little or no hesitation. In the treatment of disease he is decided, fearless, and, as a rule, fond of a remedy which produces a substantial if not visible effect. As far as hygiene is concerned, he doubtless tells his patients to live well, take plenty of exercise, and generally to cast care and trouble to the winds.

But let us take another example. C. D——, aged forty years, practicing in town, of rather spare build, delicate appearance, and nervous temperament. He is clever, scientific, very fond of metaphysical speculations, but lethargic and inactive. He generally drives, and takes but little or rarely any other exercise. His manner is quiet, timid, and unostentatious, and he is scrupulously temperate in eating and drinking. He is strictly conscientious, but too susceptible to criticism, and, therefore, vacillating and undecided. The leading features in such a man's character are inactivity and indecision, arising from an abnormal development of the intellectual and emotional centers, to the manifest disadvantage of the volitional ones. In treating disease he will probably give small doses, and often change his remedies. He will be cautious, and, on account of his timidity and want of determination, is prevented from recognizing the undoubted efficacy of the timely use of powerful remedies. And so, in giving instructions for the preservation of health, his client is so overwhelmed with cautions and contingencies which might arise that he is quite at a loss to discover how to avoid Scylla without being ingulfed in Charybdis.

The imperfect sketches of character I have drawn are illustrations of two almost diametrically opposite types, which must of necessity have a strong *tendency*, at any rate, to produce great dissimilarity of action. And so it will be found that almost every type of character, or combination of types, has a *tendency* to initiate a particular kind of action, or action varied in a particular manner. Moreover, in all cases, the type is modified by the habits of each individual. Examples might be given *ad infinitum*, but I shall only mention one or two for the sake of illustration.

Bearing in mind the number of medical men in existence, and the amount and intensity of influence each one possesses in his own circle, we may notice—

Firstly, *Influence of drinking habits.*—It has been said more than once that an intemperate doctor is often endowed with extraordinary abilities. In some instances patients undoubtedly insist on consulting a man who is for the most part positively incapable of giving any really sound advice. The cause of this fascination may be not unfrequently traced to the fact that he who uses alcohol liberally usually prescribes it regardless of *definite* quantity, to the infinite satisfaction of the patient. If such a man were requested to frame a code of hygienic laws, he would probably issue some very indefinite rules about the consumption of alcohol, perhaps altogether omit any mention of it, or advocate its free and liberal use. Let us for a moment imagine the influence of a medical man of undoubted ability, and at the same time benevolent, wealthy, and generous, but too fond of alcohol, and ask ourselves if an ethological combination of this description has not a strong *tendency* to sow broadcast the seeds of disease. On the other hand, if the same character, *cæteris paribus*, happened to be a total abstainer, surely it is not illogical to conclude that he must of necessity be the means of preventing much disease. And here I would observe that some medical men are so enthralled by the fixed idea (for it can be nothing else) that alcohol is bad at all times and under all circumstances, that they absolutely refuse to acklowledge its power as a therapeutic agent at all. While fully recognizing the amount of misery and disease which is caused by an excessive use of alcoholic beverages, surely it is totally irrational, and altogether unworthy of the progessive science of medicine, to deny the great value of their judicious and opportune administration.

Secondly, *Influence of immoral habits.*—On careful and impartial examination I believe it will be found that immorality in a medical man assists in the extension, if not in the production, of much disease. A dissolute man is scarcely likely to insist very strongly upon the necessity of leading a strictly moral life, or to dilate on the amount of disease as a probable and very frequent result of immorality. He very often argues that appetites are implanted in man for a purpose, and therefore they must be gratified.

In making the following remarks I should wish it to be very clearly understood that I do not presume nor do I feel myself justified or competent to mention them in a censorious spirit, but purely as bearing on etiology. During my student life I well remember hearing remarks and allusions, perhaps uttered unconsciously, from some of our teachers, which had a tendency to promote rather than discourage immorality in their pupils. But, further, I believe I am correct in stating that occasional acts of immorality have sometimes been recommended as the best means of averting or curing certain diseases. This may be a doubtful question, but I venture to think that such advice should never pass the lips, no, not even seriously engage the thoughts, of one whose grand professed object in life is not only to cure disease or mitigate the pain and suffering attendant upon it, but to exert himself to the utmost to prevent its origin and development.

Numerous other varieties of character associated with special habits might be mentioned, each having a *tendency* to produce its own peculiar modifications of practice. There is, however, one other type which claims our special attention at the present time. It differs very materially from any other, and has of late years attracted not only the attention of the public generally, but indecorously and indecently forced itself into the ranks of the medical profession—of course I refer to the so-called "medical woman." Now the essence of the difference between the mind of man and woman probably springs in great measure from peculiar bodily conformation. In a normal woman the sensations connected with the organs of generation (especially if we include the mammary glands) are perhaps more voluminous, if not more intense, than in the opposite sex. Is it not possible that the actual nervous supply to the generative organs—*i.e.*, the *number* of nerve fibers and quantity of nerve tissue generally—is greater in the woman than in the man? or if this be not so, may not the female sexual organs possibly have more numerous and complete communications with other parts of the body? If either hypothesis be correct, it is only rational to infer that of the threefold division of mind common to both sexes, feeling and emotion should predominate in the woman. Sexual feeling, although of different intensity in different cases, perhaps has a greater influence over the life of an individual than any other single sensation; and this idea is supported by the peculiarity of the natural feminine mind. The woman has less control over her feelings than the man, and, as a rule, to which there are many exceptions, her actions are more liable to be influenced by them than in the opposite sex. As a common result of this deficient volition we have outbursts of the hydra-headed hysteria, which I cannot but believe is well named, notwithstanding that of late years it has been somewhat the fashion to deny its frequent connection with the uterus or other portions of the sexual apparatus. For this reason, and many other well known and excellent ones, the medical profession (I wish I could say unanimously) refuse to acknowledge the propriety and decency of a woman practicing medicine. Without making too sweeping an assertion, I believe that medical women, if they became general, would have a *strong tendency* to increase immorality, and, therefore, disease. At present, as I trust they ever will remain, they are merely physiological curiosities, or mental monstrosities; but if they are encouraged by such an influential body of men as the Senate of the London University, it is possible the result may be disastrous. For my own part, had I the misfortune to meet one of these mental deformities, I should hesitate, ay, or even refuse, to acknowledge appropriately in such a person the presence of that elegant, graceful, delightful companion, so beautifully described in her primitive innocence as—

> "The fairest of creation, last and best
> Of all God's works, creature in whom excelled
> Whatever can to sight or thought be formed
> Holy, divine, good, amiable, or sweet."

And now I would ask, is there any reality in the few

* Read before the Leeds and West Riding Medico-Chirurgical Society.

remarks I have presumed to make, or are they only vagaries of my imagination? Are we not sensible, at any rate some of us (if we are only honest and dare to criticise our conduct impartially), of the existence of some trait in our character or habit of life which has a *tendency* to make us act in some particular manner not exactly in accordance with the teachings of science? Supposing these questions to be answered, as I think they must be, in the affirmative, it is only natural to ask, *Cui bono?* Is it possible to alter this condition of things? It may be urged that the influence is universal, and every one knows it and expects it. In the nature of things it must remain so, and it is useless to think that any change can be effected. Surely if there be substantial evidence of the existence of some influence which undoubtedly encourages the development of disease its universal prevalence is but a meager reason for not endeavoring to struggle against it. What can be done? Without pretending, in the slightest degree, to exhaust the question, I beg to offer the following suggestions:

1. That a knowledge of moral philosophy, including ethology, or the science of character, should be cultivated by all those engaged in the practice of medicine. In this manner it is probable that the actions and reactions of body and mind would attract more attention, and the reality of a state of mind in one individual having a *tendency* to produce a similar state of mind in others with corresponding similarity of action could not fail to be recognized and duly appreciated. It appears to me that a medical man should be competent (and this he cannot be unless he really studies character) to advise the parent or guardian of a child who has some markedly prominent peculiarity of character or vicious habit, as to the particular course of action best calculated to diminish the defect of character or eradicate the habit. It is quite as important to lay down special rules for the management of a particular character as it is to treat the child judiciously who is subject to convulsions, or the young person whose system is unable to bear with equanimity the commotion sometimes produced throughout the body and mind by the sudden transition from childhood to puberty.

2. That all medical men should endeavor to realize the existence of the above-mentioned influence, and thus make allowance for it in practice.

3. That knowing how powerful their influence is, they should endeavor to lead as nearly as possible model lives—*i. e.*, lives which will not only *bear* but *court* imitation.

I will explain briefly what I mean by "model lives." In each individual member of the human species there is an almost irresistible tendency to imitate the action of others. To this we are indebted for the greater part of our knowledge during early life. Are not those parents willfully blind or woefully unobservant who did not see their own imperfection of body and mind as it were stereotyped in those of their children? As age advances the tendency to imitate is checked by the development of volition and intelligence. It is a trite old saying, but nevertheless one well worthy of constant repetition, "Example is better than precept," and it comes home with special force to those who profess to wage a continuous warfare with disease and its various causes. Are we perpetually insisting on the necessity of an abundant supply of pure air and water? Do we think it advisable to caution our patients against an improper quantity or quality of food or any irregularities connected with the appetites? Do we believe there is any hygienic virtue in early retirement to rest, early rising, cold bathing, and scrupulous cleanliness? Have we thoroughly grasped the importance of judicious and well regulated exercise both for body and mind? If so, then it would be well to prove by our actions that with us, as medical men, these matters are not merely passing thoughts, or undigested fragments of formal advice, but positive realities of our own everyday life, and thus, independently of a strictly moral life, the value of which cannot be over-estimated, we should, I venture to think, not only *deservedly bear*, but *universally court*, imitation.

Although, as I have previously observed, the substance of this communication must at different times have occupied the minds of many of my professional brethren, the amount of influence exercised in this manner has never been gauged, and, on account of its universal prevalence has escaped, or rather has not attracted, special attention. I venture to believe that its recognition and proper appreciation can scarcely fail to be instrumental, if only to a very small extent, in reducing the amount of disease, and in giving rise to a more scientific treatment of it.—*London Lancet.*

LONGEVITY, OR THE NATURAL DURATION OF LIFE.

THE subject of Dr. Richardson's opening address at the Croydon Congress of the Sanitary Institute of Great Britain recalls to our mind an admirable paper "On the Longevity of Brain-Workers," read at a meeting of the American Public Health Association, in 1874, by Dr. George Beard, of New York. Dr. Beard wished to prove the error of the accepted teachings in regard to the effect of mental labor. He therefore obtained statistics on the general subject of the relation of occupation to health and longevity from the registration reports of England and America, and he also studied the lives of many prominent brain-workers. So far from confirming the generally-received theory that the mind can only be used at the expense of the body, his researches led him to conclude—

1. That the brain-working classes—clergymen, lawyers, physicians, merchants, scientists, and men of letters—live very much longer than the muscle working classes.

2. That those who follow occupations that call both muscle and brain into exercise are longer lived than those who live in occupations that are purely manual.

3. That the greatest and hardest brain-workers of history have lived longer on the average than brain-workers of ordinary ability and industry.

4. That clergymen are longer lived than any other great class of brain-workers.

5. That longevity increases very greatly with the advance of civilization, and that this increase is too marked to be explained merely by improved sanitary knowledge.

6. That although nervous diseases increase with the increase of culture, and although the unequal and excessive excitements and anxieties attendant on mental occupations of a high civilization are so far both prejudicial to health and longevity, yet these incidental evils are more than counterbalanced by the fact that fatal inflammatory diseases have diminished in frequency and violence in proportion as nervous diseases have increased; and also that brain-work is, *per se*, healthful and conducive to longevity.

The title of Dr. Richardson's address was "Salutland; an Ideal of a Healthy People." About three months ago Dr. Richardson and Mr. Chadwick discussed with Professor Owen the question of longevity and the natural duration of life of different classes of animals.

"With his usual scientific accuracy and industrious research, Owen had estimated, from various data he had collected, the natural term of life of that curious animal, the hippopotamus. He had learned that its term of life is thirty years. He explained to us the mode by which he had arrived at that fact; how into the calculation it had been necessary to take into account the dentition of the animal; the stages of development; the natural wearing out of the teeth; the period of gestation; the development of the skeleton into the perfection of a bony fabric, with particular reference to the combination of the epiphyses or loose ends of the bones to the shafts of the bones; and lastly, the pathological or diseased condition of the dead animal of the species that had arrived at its full longevity, in order to determine whether or not there was evidence of cause of death from disease of some particular organ, or whether there was no such evidence, but simply a history of general decay from old age pure and simple.

"We were told that in a hippopotamus which had recently died, and which was known to have just turned thirty years of age, the two sets of teeth had fulfilled their allotted duty; that the bones of the skeleton were duly consolidated; and that the organs of the body were equally degenerated; so that death had occurred not from failure of any particular organ, but from failure of the organic parts altogether. In a sentence, the animal had died a natural death, and the constant of the term of life of it and its family was set down at thirty years, a constant to which all the facts that could be collated in respect to this species of animal definitely pointed.

"From this line of facts in respect to one type of animal life we were led to others, and the rule laid down by the distinguished Flourens—by which the determination of natural old age is calculated on the basis of perfected maturity—was brought under review. The skeleton is perfected when the epiphyses or loose terminal parts of long bones are firmly united with the shaft of the bone. When the date of such perfection of development is known in the mammalian class of animals, the simple process of multiplying the age at that date by five gives the natural anatomical life of the animal. The elephant came before us as an example. A young elephant, whose history has been related in the 'Philosophical Transactions,' died at the age of thirty years. At that age the epiphyses of its bones were not completely united with the shafts. It was nearly, but not quite, matured. Multiply thirty by five, and one hundred and fifty years stand as the natural estimate of the life of the elephant; so that really an elephant might exist which had itself carried all the Governors-General of our Indian Empire. Moving from this animal of long life, we turned to the camel, to find full maturity at eight years, full life at forty. We turned to the horse, to find full maturity at five years, full life at twenty-five. We turned to the lion and the ox, to find full maturity at four years, full life at twenty. We turned to the dog, to find full maturity at two years of age, full life at ten. We turned to the cat, to find full maturity at eighteen months, full life at seven and a half years. We turned to the rabbit, to find full maturity at one year, full life at five.

"From these contemplations our minds very naturally reverted to the animal, man, to the members of the human family. Man, we learned, follows the same rule as the rest of living beings. Judged by the same test, his full maturity and full age may be calculated with equal precision. His maturity - perhaps not quite the full maturity—is twenty years. His full age, therefore, is one hundred years. This is the anatomical estimate of human life, the surest and by far the best of all that can be supplied, since it defines a law irrespective of and over-riding all those accidental circumstances of social and physical storm and strife which may interfere, and indeed do interfere, with every estimate based on the career of life itself, as it is shown in the ephemera by and through whom it is phenomenally demonstrated."

"This lesson," Dr. Richardson continues, "struck Mr. Chadwick and myself with singular force. On a surer basis than we ever trod, it corroborated a view we had ourselves promulgated from entirely different standpoints; and it further corroborated a similar view which had been advanced by our eminent friend, Dr. William Farr. We were led, in a word, once again, to the inevitable conclusion that man, even in this stage of his probation on the planet, is naturally destined to walk upon it, endowed with sensibilities of life and intelligence, for a period of one hundred years, and that until he realizes this destiny practically he is—in value of physical life—actually degraded far below the earth-mates whom he designates the brute creation, and over whom he presumes to exercise his, to them, almighty will.

"To certain parts of the scheme of natural life there is a boundary. The period of maturity of development has its boundary of twenty years, when the body, as Flourens says, ceases to grow; but if it ceases, in the ordinary sense of the term, to grow, it does not cease to increase; its nutrition improves and perfects for twenty years more at least, and then only has reached its completed physical condition. It should never from that period gain in weight, and for a long time it should not lose. It goes on now through a third period, which Flourens admirably calls the period of invigoration, during which all its parts become firmer, all its functions more certain, all its organization more perfect; and this period covers thirty years. At seventy old age begins; the *first* old age, in which naturally the fruits of wisdom are most bountifully developed, and which lasts from fifteen years to twenty, to mellow down to a period of *ripe* old age, commencing at eighty-five years and lasting fifteen years more, *i.e.*, until the constant is attained.

"And yet there need not now be death; for though, as Lord Bacon has said, old men are like ruined towers, and though, as Flourens has quoted, youths live in a double sense, with forces in reserve and forces in action, *vires in posse et vires in actu*, the *radical* forces and *acting* forces of Barthez, while old men live only on the forces in action, '*vires in actu*,' possessing no reserve, it is wonderful how the forces in action will continue after the reserve is withdrawn. This kind of half-life has continued unquestionably many years beyond the fullness of age, both in man and lower animals, and to give it twenty years beyond the natural hundred is to be just without being in any extreme sense generous.

"What we call death is gravitation; what we call disease is some accidental shot inflicted, it may be, while still the self-resistance to gravitation is in operation; what we call natural death is the gradual overweighting, at different periods, of the natural powers, reserve and acting, by the persistent force that bears us down. We cease to grow at a certain stage of our life, because of the resistance of this downward force; we cease to increase in size from the same cause; we consolidate in structure from the same cause; we bend in old age from the same cause; and we die from the same cause. Every step has practically been a death from the same cause.

"If the civilized world would continue in the ascendant, it must learn to live. An average life of forty-one, and under favorable circumstances of forty-nine years, with a world of disease and death up to that period, and a scattered struggle of the fittest for an exceptional existence into ripe old age, cannot maintain the relative efficiency of any nation, except in a world universally and equally bad."

As an answer to the question how civilized man should live in order that the natural term may be found, Dr. Richardson created an ideal people, having an ordinary term of life of one hundred and prospective term of one hundred and twenty years.

This ideal people, believing that all cities have an equal right and an equal importance, possessed no capital city, no special seat of government, no professed politicians, no army, no lawyers, and no paid physicians, every inhabitant possessing a knowledge of the laws of life and health. Animals are, however, used by this model people. Their fleeces are used for clothing, their milk for food, and many of them are made to work. The elephant works with an intelligence and skill that is almost human, and with a power that is superhuman, so that he is one of the most useful and faithful and best-beloved of all the lower animals in the land. He is the rival of the horse, which is also much cared for, and is bred in a state of great perfection for bearing the rider, to which duty he is mainly consigned.

The roads leading from one part of the country to the other are maintained in the most perfect efficiency, smooth in all parts, and dry as our best asphalt of to-day. Transit along these highways on horseback and by velocipede has supplanted most other modes of personal conveyance. The cost of coal has rendered steam locomotive power very limited, while aerial locomotion has replaced steam-propelled carriages in a marked degree. But that which has effected the greatest change in respect to locomotion has been the facility with which persons in all parts of the Commonwealth can converse by telephone at any distance from each other, the act of journeying at a pace above 40 miles an hour being considered an unnecessary expenditure of means and physical energy.

In the course of scientific development the philosophers of Salutland were led slowly to the demonstration that, in every case, crime and insanity are synonymous psychological conditions. Descending from the highest insanities to the lower and the lowest, they traced out perfect analogy; they detected that on matters of crime many men and women might be mad, while on other matters they were sane, and even capable of performing good and useful works. Thus, analyzing natural facts, they became in time bold enough to act on what they had learned. The man who can commit a crime is insane, and must be treated accordingly. To punish such a man in the ordinary meaning of that term is to try to cure one crime by committing another, which is absurd, and would be an indication of general insanity. So the insane man from crime is put with the other insane. He is moved with them to a separate colony, where, according to the nature of his offense and the character of his affection, whether it be deeply hereditary or not hereditary, and so on, he is subjected to a seclusion in which he can do no one any harm, and to such supervision and improvement as may render him fitted to re-enter society. His banishment is softened by the permitted visits of friends, and when recovery is completed he is free. But in confirmed cases, where the criminality is incurable, the law is inexorable; incurable mad men and mad women, treated with all imaginable care and consideration, are retained apart to the end of their lives. They must not corrupt others. Most of all, they must not be the fathers and mothers of a new progeny, corrupted by that most silent and potent of all corrupting influences, hereditary taint.

The education of this ideal people is never forced. Hard examinations, prizes, rewards for work—all these stimulants would be held as mentally poisonous, mere excitants of local emulation, to the exclusion of the general. Learning is universally appreciated, and the office of teacher is among the very highest in the social scale.

It is, further, a part of the whole economy of the Saluts that they never dream either of killing themselves or injuring themselves by work on the one hand, or by retirement from work on the other. They hold that a human being is constructed to perform a certain amount of work. His heart is born to deliver a certain number of beats—say, in one hundred years of natural life, three billions six hundred and fifty millions of beats. He is constituted to develop in the various organs of his body so many trillions of active cells, which make up his molecular organism, and which, duly supplied with force derived from without, are capable of performing so much work as they live and die. More force of heart, more development of cells, more life, in short, no man or woman can ever possess than that with which they are primitively endowed, as far, at all events, as are yet known, and all the free will in the world cannot change this one fundamental fact. At the same time free will can do this much: it can use its own as it likes; it can wear out its cell life altogether equally and sedately, and so live the whole allotted time, keeping a good margin; or it can wear out its cell life altogether and rapidly, leaving no margin; or it can wear out the cell life of one particular organ—brain, heart, stomach, liver, kidney—by excessive use and exhaustion of the cells of such organ, and so can kill the whole organization by the death of one organ, the rest of the organs being still in condition, perchance, for years of activity. He only should retire from active work from whom work retires, is another idea and practice so faithfully followed that every town yields many workers who, like Titian the Great, are doing their full quantity at the centenaries of their births. For all necessary purposes—such is the easy and equal distribution of labor, and so comparatively light are the tasks of labor—from three to four hours in the twenty-four are sufficient for everything that needs to be done, by the busiest of the busy, to keep the social machine in perfect order.

Thus, in Salutland, ample time is left for the pursuit of every useful, healthy, and ennobling occupation. Its happy people cultivate every beautiful and refined art, every branch of natural science; their literature, chiefly of Nature and of Life, and History of Life, while it has lost none of the brilliancy and point of the present rapid method, is deeper and richer and newer. The age of criticism has passed away. To visit all the planet, make the grand tour of the earth; to know all history by biography, so that no man or

woman who has helped humanity a hair's breadth on its way may escape their appreciative and correct knowledge; to compare all artistic existence with the nature from which it sprang; to read men through the languages they have spoken; to study the physical directions of mental phenomena, and from the repetitions of history to forecast even history: these are the studies of their learned men; and the texts from which the learned impart their stores of erudition. To perfect these studies every means is offered by which, without prize giving, or other false stimulus, the choicest rivalry may be naturally imported. Music is most perfected. The stage maintains its reputation, and is utilized to the grandest purposes. Art in the form of sculpture is encouraged with the greatest care. Architecture is another profession which vies in splendor. Here, too, the true painter has found a home. Science is the unembodied Nestor of the teacher and the taught. To know is to exist; and Science is knowing, existing. For the museums of Science, the collections of the works of the Universal Father, the architect expends his best designing energies, the builder his finest work, the mechanist his choicest skill. Astronomy still heads the line of the pure sciences, chemistry follows, and meteorology, geology, natural history, anthropology, mechanics, and engineering, and other sciences find all their true places. Health science stands alone; it includes all the rest. *Salus salutis; scientia scientiæ.*

While thus, in systematized order, the gentle and refining arts and sciences are cultivated as exercises for the mind, the physical health is tended with equal care. Out-door life is the first thought, and out-door exercises of a skillful and useful character are to the fullest extent encouraged. All the young are taught to swim, to row, to ride, to skate, to walk with ease and stateliness, to climb, to play at invigorating games, to dance, to speak in public, and to become efficient in the gymnasium. The daily ablution in the bath, the daily exercises of muscle and limb, are made as distinctive necessities as the taking of meals; and, withal, the dress in which the body of both sexes is clothed is made so loose and obedient to every movement that no deformity of body from dress is possible.

With regard to the health of the Saluts they have mastered the pestilential diseases. An epidemic from pollution of air, of water, of food, is with them impossible. The hereditary tendencies to disease are either lost altogether or are so nearly eradicated as to be practically removed. The diseases incident to poverty are stamped out by the removal of their cause. The diseases incident to intemperance and luxury are stamped out by the removal of their causes. The diseases incident to occupation are stamped out by the careful and easy expunging of everything that is injurious in occupations. The diseases incident to worry are stamped out by the abolition of maddening, exhausting, and useless strifes and ambitions. In a word, this people contends only with the natural elements—the heat of the sun, the flash of the lightning, the changes of atmosphere—from the fatal effect of which they rarely suffer; and with the one destroying inevitable power, the gravitation of the earth, which brings old age and death.

Thus, with the fewest accidental exceptions, the men and women attain the sacred age. Their death rate is normal and constant, at eight in the thousand per year, and death itself—painless, final sleep—is hardly more than departure to rest when the day of work is done.

Referring to the simple means by which these results were achieved, Dr. Richardson says these settlers had become indoctrinated in their own land with the elementary truths relating to public health. They had learned the lesson of physiology; they had acquired a certain knowledge of what were and what were not healthy places. They had learned the history of the diseases produced by uncleanliness, had become practiced in the useful and innocuous distribution of sewage, and had seen the dangers that arise from pitching dwellings in damp localities, and in building dwellings with materials that absorb and hold water. In accord, in spirit, with the best information on these points, they carried out the spirit to the letter in their practice, and so began on a new and sound foundation. Ignoring all thought of false economy, destroying by fire all carriers and sources of contagion, and providing for the instant isolation of every case of contagious or infectious disease, they stamped out the communicable diseases wholesale, with a success and readiness which were surprises even to the most sanguine preventionists, and which gained for them ten years of life.

The science of medicine, which in its true and honest position is always in the front rank of advancement, was somewhat changed. The doctors continued to keep a correct history of diseases, of the course of diseases, and of the causes of diseases, but they added an equal knowledge of prevention, particular and general, and valued that knowledge most. Dismissing all special modes of cure by particular systems or assumed specifics, they determined to know once and forever what diseases would not get well without the aid of medicines of any kind, the general conditions for recovery being rendered as perfect as was possible. This discovery of the triumph of preventive art did not, however, satisfy altogether. It left on record the fact that Nature never goes out of her path to cure, and that what has been called the *vis medicatrix naturæ* was as much a myth as any other of the past myths of physic. It left on record, also, that under the happiest apparent external conditions some diseases will run their fatal course as decidedly without medicines as with them.

The diseases which so progressed were, in turn, discovered to be diseases of what we call constitutional type, depending upon heredity. They were four in number: Scrofula, with its attendant, pulmonary consumption; cancer; specific disease; and insanity. The majority of the physicians, seeing the results I have named, began at once to teach that, as these diseases were obviously diseases of descent, and were maintained by the intermarriages of persons subject to them, there was only one sure and certain mode of removing them, and that was a common-sense rule that such intermarriages should not be tolerated.

The physiologists, dealing with the two questions of digestion and food for digestion, were led to the conclusion that a considerable shortening of life was induced by the excess of work which was put on the digestive organs. They bore in mind that many persons die from the wearing out of one particular organ, the rest of the organs being still healthy. Of all organs they agreed the stomach is most exposed to this danger. They found, on inquiry, that the stomach was distressed both by quantity and quality of food. Following a suggestion thrown out by Flourens, they decided, on anatomical grounds, that man was neither herbivorous nor carnivorous, but a frugivorous, or fruit-eating animal. Next they estimated the precise amount of food and of drink that was necessary to support the reserve and the active life in the varied stages of life. Again, they determined the reduction of food that is required when the reserve life is withdrawn, and when the active life being left alone, it is the more requisite that no additional surplus of tissue or fluid, fat or water, should encumber the body; that no excess of force should be supplied to the digestive organs to the deprivation of other organs equally important, and that no over taxation should be cast on the digestive organs themselves. Step by step, they were led hereupon to the introduction of an entire change of food and feeding. Animals were given up as sources of sustenance; fruits became greatly in demand; the bread tree competed with wheat grain; the banana and the grape were called largely into use; the juices of fruits almost entirely superseded water as beverages; while chemistry, coming in always to the assistance of man, easily transmuted many vegetable substances into the most perfectly digestible of foods for every variety of age and constitution. Of purely animal substances, milk only, and the products of it, butter and cheese, retained full sway. Of the vegetable kingdom not frugivorous, cereals, pulses, tomatoes, potatoes, and other fresh vegetables, with the edible Fungi, retained their useful place; and in respect to quantity of food and drink, not more than half by weight began to be consumed compared with what had been consumed before.

The last of the later advancements in order of time, and the final in order of complete accomplishment of obedience to natural design, had relation to sleep and rest. When the sun became the fellow-workman of the people of Salutland, the redemption of their bodies from premature death was carried out with the fullest success. The people saved millions in money, but this was nothing to the other saving. That nervous system of theirs—that system which takes in the outer universe, which is stirred by its waves, and sleeps, if it be permitted, when the waves sleep—found at last its natural time for work and for rest. All Salutland laid down like one vast living world to enter oblivion, and to wake from it filled with another spell of life, ready and happy to greet another day.

If there were any hope of Dr. Richardson's city and people having any other than an ideal existence, we might dismiss from our minds the arguments put foward by Dr. Beard in support of his theory; but as there is no likelihood of such a state of perfection being reached, at all events in the present generation, it will be well to consider the conditions which favor the brain worker, with the view of extending some of them to the muscle worker, or at any rate of improving his social and intellectual condition. The causes to which Dr. Beard attributes the greater longevity of the brain-working classes are: 1. The inherent and essential healthfulness of brain work. 2. Brain workers have less worry, and more comfort and happiness, than muscle workers. 3. Brain workers live under better sanitary conditions than muscle workers. 4. The nervous temperament, which usually predominates in brain workers, is antagonistic to fatal, acute, inflammatory disease, and favorable to long life. 5. Brain workers can adapt their labor to their moods, and hours and period of greatest capacity for labor, better than muscle workers.

The study of vital statistics led Dr. Beard, moreover, to the conclusion that, other conditions being the same, the greater and richer the brain the greater the longevity; and he shows that the greatest men of the world have lived longer, on the average, than men of ordinary ability in the different occupations by fourteen years; six years longer than physicians and lawyers, nineteen or twenty years longer than mechanics and day laborers; from two to three years longer than farmers; and a fraction of a year longer than clergymen, who are the longest-lived class in our modern society. The causes of this exceptional longevity are: 1. Great men usually come from healthy, long-lived ancestors. 2. A good constitution usually accompanies a good brain. 3. Great men who are permanently successful have correspondingly greater will than common men, and force of will is a potent element in determining longevity. 4. Great men work more easily than ordinary men.—*Jour. of Science.*

WHITE HYDRAULIC CEMENT.—Fahnejelm recommends the snow-white powder obtained by calcining, at a red heat, a mixture of 75 parts of whiting and 25 of washed kaolin, and then grind it, as an excellent hydraulic cement, either when employed alone, or with the addition of a small percentage of plaster of Paris. Tests made show that it acquires great tenacity under water. Too high a temperature in calcining will impart a bluish tint to the cement.

HOW TO CONTROL SEX IN ANIMALS.

A FRENCH veterinary surgeon, Prof. Thury, of the Academy of Geneva, having studied with particular care the sex of the offspring, with reference to the date of conception, found that when the male was given at the first signs of heat in the female, the result was a female, but when the male was given at the end of the heat, the result was a male offspring.

A certified report to the Agricultural Society of Canton de Vaud, Switzerland, in 1867, gives the result of the careful testing of Prof. Thury's law in the following words:

"I desired to have heifers. My cows were of the Schurtz breed, and my bull a pure Durham. I succeeded in three cases. Having bought a pure Durham cow, it was very important to me to have a new bull to supersede the one I had bought at great expense, without leaving to chance the production of a male. Accordingly, I followed the advice of Prof. Thury, and the success has proven once more the correctness of his law. I have obtained from my Durham bull six more bulls for field work, and having chosen cows of the same color and height, I obtained perfect matches of oxen. In short, I have made twenty-nine experiments after the new method, and in every one I succeeded in the production of what I was looking for—male or female. I *had not one single failure.* All the experiments have been made by myself, without any other person's intervention; consequently I do declare the law discovered by Prof. Thury to be real and accurate."

A few months before the death of Prof. Agassiz, the writer of this article had a long conversation with him upon this important subject, and he expressed a strong faith in the theory, saying that he knew Prof. Thury well, and that he was a scientific observer, who was absolutely incapable of saying or doing anything which was calculated to mislead the public, and that the most implicit reliance could be placed upon any statements made by him.

With such well authenticated facts before them, it would seem that the farmers of the United States need have no difficulty in breeding with almost absolute certainty, so far as sex is concerned, just the animals they desire, either for their use or for the market; and as the subject is one which opens up a broad field for interesting experiment and inquiry, without risk or expense, and is of great practical importance, we shall hope to hear, in the course of the coming year, the opinions of many of our readers, and the results of their experience with the theory.—*N. E. Farmer.*

GUM EUPHORBIUM.

SOME years ago, at Natal, in Zululand, some of the laborers belonging to the colonial government, during the progress of their work, remarked that certain plants belonging to the natural order *Euphorbiaceæ*, when cut with an iron or steel tool left a very adhesive coating of gum on the metal, and one very difficult of removal. And they also discovered that a metallic surface covered with this material was no longer subject to rust. This observation led to experiments to ascertain whether gum euphorbium could not be utilized in a practical way for the preservation of metals generally. Plates of iron were therefore coated with the substance and immersed in the waters of Southern Africa, which are well known for their deleterious action and for the rapidity with which vegetation develops in them. Euphorbia grows at Natal, very near the coast, so that nothing was more convenient and easier to ascertain than the fact as to whether the gum from the plant possessed the qualities attributed to it—whether it really would prevent iron from being corroded by the sea water and attacked by vegetation. These experiments having proved a success, an effort was made to ascertain whether a practical application could be made of the discovery. With this object, gum euphorbium was dissolved in a preparation of spirits of wine, and it was found that in this way an easy means was obtained of coating the hulls of ships, and the surfaces of all metals needing this mode of preservation. The alcohol on evaporation leaves the surface coated with a clean hard coating of the gum. The first experiments were pursued yet further. Plates of iron coated with the gum were sunk in the water at the Chatham docks, where everything quickly corrodes or decays. At the end of a couple of years it was found on examination that the iron was perfectly clean and had undergone no corrosion whatever. In Africa the same substance has been experimented with successfully as a preventive of the attacks of white ants. Success in this case has been attributed to the bitterness of the gum, which prevents the insects from perforating substances coated with it. It is said that this new preservative is now being introduced into England. In addition to the other properties attributed to it, it may be stated that it gives quite a luster to objects covered with it, and also preserves them against the action of the atmosphere.

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TABLE OF CONTENTS.

I. ENGINEERING AND MECHANICS.—Machines for the Production of Ornamental Papers. Illustrations of machinery for making and printing wall paper, shown at the Paris Exhibition. Fig. 1. Machine for dampening figured paper previous to satining. 2. Machine for sheeting and sizing paper. 3. Machine for printing paper in eight colors. Machine for satining paper.... Page 3

Revolving Cylinder Steam Engines. Fig. 1. Revolving cylinder steam engine. 2. Revolving steam engine (Scott & Morton's). 3. Revolving engine, in perspective. 4. The same in sections. 5. Revolving cylinder steam engine.... Page 3

New Application of Centrifugal Pumps. Submersion pump. Exhaust pump for graving docks. Pumps for soft mud. Pumps mounted on turbines.... Page 3

New Oscillating Crucible Furnace. 4 figures.... Page 3

Endless Rail Railway. Clement Ader's System. Fig. 1. Train of endless rail goat carriages in the Garden of the Tuileries. Fig. 2. (Section) Front and rear of train, with a system of endless rails.... Page 3

Improvements in Bridges. By RICHARD B. OSBORNE. Description of Osborne's Stalical Suspension Truss. 3 figures.... Page 3

Holes for Blasting Treated with Hydrochloric Acid. Method of enlarging blast holes, and its economy.... Page 3

American Cotton Mills as Viewed by an Englishman. Labor systems of American mills. Construction of American cotton mills. Cost of building. Repair shops. Taxes. Character of working population. Hours of labor. Steam vs. water power. American cotton manufacture.... Page 3

The Improvements Science can Effect in our Trades and in the Condition of our Workmen. An extremely valuable and suggestive address by Prof. W. E. AYRTON, City and Guilds of London Institute, England. Why many inventions are of American origin. Education in modern life. Importance of a knowledge of electricity. The groundwork of education. Importance of a general knowledge of principles, etc.... Page 3

II. ELECTRICITY, LIGHT, ETC.—Stereoscopes for Large Pictures.... Page 3

Magnetic Circuits in Dynamo and Magneto Electric Machines. Experimental researches by Lord Elphinstone and Chas. W. Vincent. 1 figure.... Page 3

Clamond's Thermo Electric Pile. 1 figure.... Page 3

A Chloride of Lime Battery. By ALFRED NIAUDET.... Page 3

III. TECHNOLOGY AND CHEMISTRY.—The Neutralization of Phosphorus in Steel and Steel-like Metals. By RICHARD BROWN. A valuable paper read before the British Iron and Steel Institute.... Page 3

On the Separation of the Heavy Metals of the Ammonium Sulphide Group. By CLEMENS ZIMMERMANN.... Page 3

Silver Oxide Fire. By Prof. BOETTGER.... Page 3

On a New Method for the Separation of Nickel and Cobalt. By PH. DIEWELL.... Page 3

The Function of Chlorophyl. Prof. Pringsheim's report to the Berlin Academy reviewed by SIDNEY H. VINES.... Page 3

Houlgrave's Gelatine Emulsion. Description of the method of preparing his gelatine emulsion, with formulæ. By WILLIAM HOULGRAVE.... Page 3

On the Solubility of Solids in Gases. J. B. Hanna's investigations.... Page 3

IV. GEOGRAPHY AND NATURAL HISTORY.—The Swedish Northern Passage Expedition. Prof. Nordenskjold's report of observations.... Page 3

Cerro de Pasco, Peru. Description of town and the silver and other mines of the neighborhood.... Page 3

Coursing.—The First Turn. Large illustration.... Page 3

The Pearl Fisheries of the Persian Gulf. Official report of Capt. Durrand, of the British Protectorate of Persian Gulf.... Page 3

V. MEDICINE, HYGIENE, ETC.—On the Hygienic and Therapeutic Influence of Habits and Character in the Medical Profession. A highly suggestive and important address by Dr. Edward T. Tibbits.... Page 3

Longevity, or the Natural Duration of Life. Dr. Richardson on Longevity of brain workers. Increased longevity a result of civilization.... Page 3

How to Control Sex in Animal Births.... Page 3

VI. MISCELLANEOUS.—White Hydraulic Cement.... Page 3

Gum Euphorbium, protective of metals, etc.... Page 3